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GEOGRAPHIES FOR ADVANCED STUDY

EDITED BY PROFESSOR S. H. BEAVER, M.A.

THE SCANDINAVIAN WORLD

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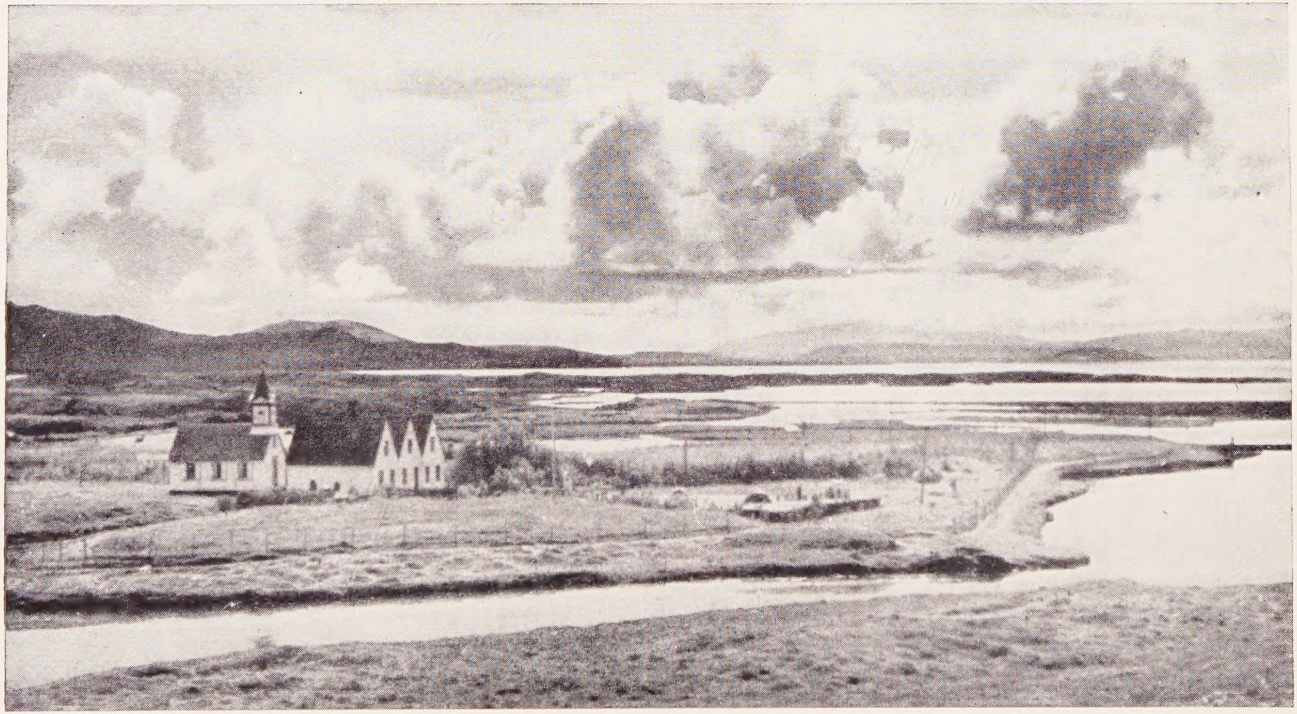

VIEW FROM THE HILL OF LAWS AT ÞINGVELLIR, ICELAND.

"Here, long ago, at a period when feudal despotism was the only government known throughout Europe, free parliaments used to sit in peace, and regulate the affairs of the young Republic." (Lord Dufferin, *Letters from High Latitudes*, Letter VII, 1856.)

THE SCANDINAVIAN WORLD

BY

ANDREW C. O'DELL, M.Sc., F.R.S.E.

Professor of Geography in
The University of Aberdeen

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Dedicated

to the memory

of the late

CMDR. FRANK NOËL STAGG, R.N.

Commander of the Danish Order of Dannebrog

Commander of the Norwegian Order of St. Olav

and

Friend of Scandinavia

PREFACE

Geographers born and bred in Scandinavia are in many ways in a better position than a non-Scandinavian to write a geographical review of the Scandinavian World. My main justification for attempting the task is that no one living in that area has done so and it may be that living as I do in Aberdeen, on the periphery of the present sphere of Scandinavian influence, gives me the advantage of a detached point of view.

My interest was first aroused when I visited Norway in 1932 in connection with a study of the historical geography of the Shetland Islands. Since then I have made visits to various regions from Luleå and Bornholm in the east to Reykjavík in the west, from Jylland in the south to Spitsbergen in the north. On my travels I obtained not only information, but also received much kindness from so many people that it is impossible for me to mention them all by name. Invaluable assistance has been given by correspondence, by conversation and in the field from the following: for Norway, Professor F. Isachsen of Oslo and Professor A. Sømme of Bergen; for Sweden, Professor G. Enequist of Uppsala, and Professor Hoppe of Stockholm; for Denmark, Professor N. Nielsen, Dr. V. Hansen and Professor J. Humlum; for Iceland, Professor Einar Ol. Sveinsson, Dr. Kristján Eldjárn and Dr. Sigiður Þórarinsson; Dr. Aa. Kampp gave much valued advice on the Færoes and Count E. Knuth on Greenland. Several of the above were kind enough to read drafts of the regional chapters which related to their personal interests and to draw attention to errors of fact or interpretation and to sources of further information. A book such as this could not have been written without access to the vast geographical literature, particularly in periodicals, which has grown up about the Scandinavian World and I am indebted to many, particularly to those who have allowed me to base diagrams on their published work.

As a result of the war there has been a closer association of the Scandinavian countries with Britain and I have been fortunate in obtaining contacts and inspiration at the Viking Congresses held in the Shetland Islands (1950), Bergen (1953) and Reykjavík (1956). At the first, the late Professor H. Shetelig aroused an enthusiasm for the Viking period while Professor Dag Strömbäck of Uppsala and Professor C. Matras of Copenhagen created an interest in traces of the past which still linger in the present.

Of help I have received none transcends that of Professor S. H.

Beaver. He has given freely of his time and energy and without his keen eye and interest this volume would never have been completed in its present form. Few authors can have received so much assistance from the General Editor of a series. A number of maps have been created, as well as drawn, by Mr. F. M. Synge and noteworthy among these is the sequence of ice retreat (Figs. 2–7) and the diagrams of Verdal (Figs. 92 and 93). The proofs have been read by Professor S. H. Beaver and by my wife while the latter also greatly assisted with the onerous task of preparing the index.

Difficulties have arisen over statistics. While some countries publish returns soon after collection others do not issue them so frequently. This has led to the statistical statements being given for the latest year in which figures are available for each country and not for the latest available for any one country. It is believed that the figures given provide a fair statement of the scale and trend of their subject matter. The statistics issued by the United Nations Statistics Office are particularly valuable in that they are corrected to common standards.

A. C. O.

M/S *Gullfoss*

In the six years since this book was first published economic conditions have changed.

There has been a considerable increase in the geographical literature. On the occasion of the International Geographical Congress at Stockholm in 1960 the work of Scandinavian geographers was displayed both in the field and through the publications for the Congress.

The work of revision for the Third Impression has been eased by considerable assistance given by Mr. E. Alistair Smith, M.A.

A. C. O.

April, 1963

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Fig. 18 based, by permission of the Director of the Meteorological Office and the Controller of H.M. Stationery Office, on the Daily Weather Reports for 18th February and 11th March, 1939.

PART I

PHYSICAL AND HISTORICAL INTRODUCTION

CHAPTER 1

INTRODUCTION

In this volume the widest reasonable interpretation is made of the term Scandinavia.[1] The name Scandinavia, in the forms *Scatinavia*, *Scadinavia* and *Scandia*, is first found in Pliny; through the errors of later copyists it became corrupted to Scandinavia, and instead of being applied to the islands was used as a name for southern Sweden. In the early account by Ptolemy, *Scandiae* denotes the Danish archipelago and southern Sweden.

Scandinavia is a name which is applied to different groups of countries, sometimes rather loosely, and there is need to justify the use of the term, for some or all of the northern countries of Finland, Sweden, Denmark, Norway and Iceland are variously included. Geologically the greater part of the Scandinavian peninsula and Finland is termed Fenno-scandia, or the Baltic Shield, and this structural unit, as defined by Ramsay, extends eastwards to the Kola Peninsula and to Karelia north of Lake Onega. Yet this name is not sufficiently comprehensive to cover what is popularly included within Scandinavia for, *sensu stricto*, the greater part of "Caledonian" Norway is omitted as also are Skane and Denmark which are structurally part of the North European Plain. The only geological feature common to all the areas which can be described as Scandinavian is the Pleistocene glaciation. Part of the similarity of appearance has been given by the movement of vast masses of ice across the land surface during the Ice Age. The presence of rock-basin lakes, morainic drift, thin soils, overdeepened valleys and kindred phenomena of a glaciated terrain profoundly affected the ways of life and the outlook of a people living within such an environment. These glacial features vary in importance within the Scandinavian World but overriding all is the common feature of a northern climate moderated, to a greater or lesser degree, by maritime influences. Climate, with all that it means in the adaptations

[1] The derivation of the name has been much debated. Did it come from the Old Norse goddess *Skaði* or from *Skaðavin*, "cattle pasture", or from *Skadinaujo*, proto-Nordic for Skadde-ey, "Foggy Island"?

demanded by buildings, agriculture and social life, has been a powerful factor in forging the unity.

Other approaches to a definition lie through ethnography and linguistics, for most of the inhabitants speak one of the Scandinavian group of languages. The linguistic approach includes Denmark, which is omitted by taking a structural basis, but omits all Finland, except the western fringe, for the Finno-Ugrian language of the Finnish people has different roots from the Scandinavian languages. Icelandic is a North Germanic language, while Færoese, although related to West Norwegian, is not purely Scandinavian. Ethnographically too there is incomplete coincidence with the popular use of the term. Yet running through the historic scene there is a constant reiteration of a Scandinavian culture and common links in the heritage in the various countries. Boundaries of the kingdoms have ebbed and flowed—Sweden expanding her political control over Finland and Norway, Denmark over southern Sweden and Norway —and during these periods, in particular, ideas were shared.

Scandinavia is situated in the gulf of winter warmth where the winter temperatures are above the mean for the latitude. The salt seas are generally free from ice and these countries all have a long coastline, with a maritime tradition and a common source of livelihood (invaluable compared with the meagre agricultural output of so much of the land), which is most slightly developed in Finland. What port in the world has not seen the flags of the Scandinavian States fluttering at the mastheads? This is no modern tradition: for over a thousand years ships have left these shores and the "discovery" of America by Christopher Columbus is now known to have been long antedated by the Norsemen. It was this marine activity which shared and spread the culture which may be thought of as Scandinavian. The northern territories of Svalbard, Færoes, Iceland, Greenland and Jan Mayen Island were all gradually brought within the orbit of Europe by the seafarers coming from Scandinavia, although the Dutch and the English may have shared in their discovery.

Some regard Denmark as an extension of the European Plain, Finland as within the Russian sphere of influence and Sweden as being most closely associated with the Baltic, yet all the main members come together at the Skagerrak for their principal outlet to the North Atlantic. Once the Hanseatic League control of this key area was broken northern ideas prevailed and their modern political organisations, whether monarchies or republics, are true democracies. After a turbulent existence when Denmark and Sweden were first-class European powers they had a long period of neutrality when the crafts and arts flourished undisturbed by wars. This period was

interrupted by economic troubles, such as the catastrophic fall in grain prices, when Denmark and Sweden had to revolutionise their agriculture, or the disturbed trade conditions during the reorganisation of Finland after two world wars or the readjustments after occupation by armed forces of the whole area except for Sweden. Their contribution to modern society includes the development of co-operation and the introduction of a number of features of organisation in a Welfare State. Such features of social life have been created in lands of sparse population and where the population has long been drained by emigration.

Certain large assets are common to several of the States: forest wealth to Finland, Sweden and Norway, fisheries to Denmark, Norway, Iceland and Færoes, hydro-electric potential to Finland, Sweden, Norway and Iceland. This similarity of resources produces a certain amount of healthy competition between the various countries, particularly since their outlook to the sea has given rise to great, modern, merchant marines. Much of their similarity of outlook is due to location, and yet the relative position of Finland and Sweden kept them out of the North Atlantic Treaty while other countries realised the new power politics which could not tolerate in war a traditional neutrality. It is a measure of international opinion of Scandinavian impartiality that the first two men to occupy the position of Secretary-General of the United Nations were a Norwegian and a Swede.

The northern countries have produced illustrious names in science, pure and applied, in arts—music, literature and sculpture—and in exploration. In relation to the numbers of their population the output has been considerable and the Scandinavian contribution, which is of high quality, is one which reflects the virility of outlook.

There is then a Scandinavian area, physical and cultural, and from it cultural influences have spread along historic routes. These areas where the influence of the Northmen is still felt in modern life are considered in this volume. Areas, such as northern Scotland, eastern England and northern France, which were once part of the Scandinavian World but are now dominated by other cultures, are not here examined, but the wide sector of the Arctic margin from Finland in the east to Greenland in the west, a sector stretching nearly one-eighth of the globe, which is still Scandinavian in culture, is here presented from the physical, regional and economic aspects.

CHAPTER 2

STRUCTURE AND RELIEF

The Scandinavian World is largely formed of two main groups of rocks: the ancient rocks forming the Fenno-scandia province, that is the core on which the continent of Europe has been moulded, and the geologically recent outpourings of igneous rocks. While there are outcrops of Palæozoic, Mesozoic and Tertiary sediments, and their economic value in the aggregate is considerable, the area occupied by these outcrops is relatively small.

GEOLOGICAL FORMATIONS

To facilitate reference to geological literature a brief account is given of the principal formations and their characteristics in the Scandinavian World. The table correlates the oldest geological formations from the Baltic to Hudson's Bay as a synopsis of the various names used.

Summary of oldest geological formations

	North America	*Scotland*	*Sweden*
Algonkian	Keweenawan	Torridonian	Eocambrian Jotnian
	Huronian	Dalradian Moinian	Sub-Jotnian Karelian
Archæan	Keewatin	Lewisian	Gothic, Sivonian and older periods

Archæan and Pre-Cambrian

The so-called Fundamental Gneisses of southern Sweden have been formed from either igneous or sedimentary rocks which, by the intrusion of granite, have been highly metamorphosed. The oldest group yet recognised is the *leptite* which, sometimes only partially absorbed in the uprising of the granite magma, frequently contains the more valuable ore deposits. The granites are not all of the same age and three or four groups have been determined; it is probable that these intrusions represent periods of earth movement which were the stormy interludes between the periods of stability during

which the sediments were deposited. Towards the close of the Pre-Cambrian when the land surface was high and igneous activity was not strong, great thicknesses of sandstone began to accumulate and the much eroded, but not metamorphosed, fragments of these are found in south-west Finland and in central Sweden. These sandstones are the equivalent of the Torridonian Sandstone of north-west Scotland.

During Pre-Cambrian times there were four mountain building periods and traces of the stumps of these mountains have been distinguished in Fenno-scandia by their mineralogical content. Finnish geologists have recognised in the Archæan era the Svecofennides and Karelides, the former characterised by granites intruded into schists and the latter by heavily metamorphosed mica-schists and quartzites. In Greenland traces of two mountain ranges have been distinguished in the Pre-Cambrian.

Palæozoic

Unlike these rocks in Britain those of Scandinavia have frequently been preserved with the strata in their original horizontal bedding for they have only been disturbed by block-faulting. After the deposition of the Jotnian Sandstone (Pre-Cambrian) there came a great erosion period which stripped much of the sandstone away and the debris was laid down anew in a formation which includes sandstones, slates and limestones. In Finland Palæozoic rocks occur in the form of sandstones, schists and volcanic rocks but usually their area and thickness is slight. Subsequent block-faulting has locally preserved these little-resistant rocks while elsewhere they have been preserved under a protective cap of later igneous material.

Folding movements, as contrasted with fracturing, virtually ceased in Fenno-scandia after the Pre-Cambrian period for by then the rocks forming the shield had been made stubborn and resistant by intense compression. In Norway, as a result of pressures from the west, there is a great thrust plane, which locally has a thrust displacement of over 80 miles (128 km.), and the Palæozoic rocks have been metamorphosed in the compression and folding.

The region where this great Scandinavian overthrust can best be studied is Jämtland where the older Palæozoics, which largely rest on igneous material, pass to the north-west under the overlying mountains with the great nappe structure and thrust zone, the opposite margin of the Caledonian Chain to the Moine thrust of Scotland; the structure of the Scandinavian thrust was elucidated, almost single-handed, by Tornebohm while Peach and Horne were working in north-west Scotland. The south-eastern edge of the Scandinavian nappe is, as a result of structure and erosion, very sinuous,

while in front of the edge are great outliers and behind are anticlinal "windows" through which can be glimpsed the underlying rocks. The anticlinal crests of the nappe structure have been eroded away, thus exposing windows to the underlying Pre-Cambrian rocks whilst the synclinal folds, more resistant and less exposed, have not yet been eroded.

Mesozoic

The framework of Denmark and of Skåne is composed of thick deposits of late Cretaceous chalk which outcrop from north Jylland through the archipelago into southern Sweden. Occasionally the chalk outcrops at low cliffs which are known as *klint*. The Senonian and Danian chalk beds are the most important Cretaceous deposits in Denmark and in Skåne for they contain the valuable flint concretions which aided the material development of stone-age man, and they also produce a warm, lime-rich soil.

Tertiary

The sedimentary deposits which vary from sandy to clayey are most significant in Denmark for they underlie the glacial deposits of most of Jylland. Included in these strata are the lignite beds of Denmark which are of value in times of war and of economic distress. At the close of Tertiary times there were earth-movements equivalent to those at the close of the Cretaceous period and the sedimentary beds were then thrown into folds which were partly denuded before the Quaternary beds were laid down on top.

Of greater significance than the Tertiary sediments in creating a land surface are the igneous outpourings.

Aggregate thickness of Tertiary lava beds

Area	*Thickness*		*Authority*
	ft.	*m.*	
Scoresbysund, E. Greenland	15,000–20,000	4,575–6,100	Wager, *Medd. Grønld.*, cv., 1934, p. 30
Iceland	11,000	3,350	Hawkes, *Geol. Mag.*, 1916, p. 385
Færoes	14,000	4,260	Simpson, *ibid.*, 1928, p. 511
Mull-Ardnamurchan	6,000	1,830	J. E. Richey, *Scotland, the Tertiary Volcanic Districts*, 1935

The Færoes and Iceland are formed of igneous rocks, the base of which cannot be seen, and these basalts are part of the so-called

North Atlantic Tertiary Volcanic Province which extends on the one hand to west Greenland and on the other to Antrim and Skye. These igneous rocks contain interbedded sandstones and shales, occasionally sufficiently carbonaceous to be worth working. Also of Tertiary age but younger than the basalts are the lavas which form central Iceland and Jan Mayen. Superimposed on these are the products of a vulcanicity which has continued from the Pliocene to the present day.

STRUCTURAL REGIONS

According to Edward Suess the structural units of the area forming the Scandinavian World were the pre-Carboniferous substructure

FIG. 1.—PRINCIPAL STRUCTURAL UNITS OF THE NORTH ATLANTIC REGION.

This map, on the azimuthal equidistant projection, shows the great arc of the Caledonian folds extending from southern Scotland to northern Canada with a conjectured branch parallel to the east coast of Greenland. Some writers have extended this branch further towards Cape Farewell.

Based on E. Suess, *The Face of the Earth*, Oxford, 1906 and O. B. Bøggild and L. Koch, *Greenland* Copenhagen, 1928.

with in Finmark a section of the Uralides and along the west coast of Norway the Caledonides, the Greenland sector of Laurentia and between a large area of islands formed by the Atlantic type of

vulcanicity. Of these units the most significant structurally is that of the substructure of Fenno-scandia, largely coincident with the Baltic Shield which, on account of faulting and depression with extensive marine transgression, does not now reveal its true extent. The present outcrop is a portion of one of those Archæan masses—the others are now represented in the Siberian and Laurentian Shields—which once tapered southwards from the Arctic Ocean. All these ancient blocks reveal similar characteristics, namely, intensely folded and metamorphosed rocks with a denuded surface which is higher towards the margins and is of low relief in the centre. Ramsay took as his limit of the Fenno-scandian province on the west the Glint line where the Palæozoic rocks have been eroded back to form an escarpment, or occasionally a depression, along the edge of the present outcrops of the Archæan platform. It seems certain that this platform once outcropped farther to the west but faulting and overthrusting, followed by erosion, have caused the western boundary to retreat eastwards. While fragmental outcrops of younger rocks occur along the fractured edge the essential character of this structural province is given by the core of Archæan rocks and its rim of Palæozoic material.

Towards the east and south occurs an area of Palæozoic and later rocks, part of the structural unit underlying the North European Plain, but in the Scandinavian area the outcrop is mainly masked by glacial deposits.

On the surface of the Scandinavian peninsula a distinct geomorphological feature is the sub-Cambrian peneplane which is recognisable from Finmark to Hardanger and to Stockholm although deformed by later folding and faulting and removed locally by erosion. There are also two Tertiary erosion surfaces, which appear as plateaux, as in southern Norway, or elsewhere as isolated hills.

The fracture lines of Fenno-scandia have been of profound importance in the evolution of the landscape and of man's response to it. Most of the significant lines of fracture were created, or recreated, in the Miocene period and the three principal alignments are east to west (passing to east-north-east to west-south-west), south-east to north-west and approximately north to south. Portions of the coastline, the outline of the lakes, the pattern of the drainage, the lines of igneous intrusions and the grain of the horst hills of central Sweden constantly reiterate the alignment of the faults which has dictated their pattern.

ICE-CAPS AND GLACIERS

At its maximum extent, the Scandinavian ice-sheet made contact on the east with the flow of ice from the cap on Novaya Zemlya and

on the west with that of the British Isles. In the last glacial phase however it failed to reach these other ice-caps. Then the ice-cap on the Scandinavian peninsula dwindled to two centres, north and south of Ragunda, and this stage is taken by Swedish glaciologists as marking the start of post-glacial time. To-day there are many fragments of ice cover in existence. Norway has a greater area of glaciers than the Alps but these glaciers are a fresh collection of ice which commenced after the Ice Age and they are not relics of the Ice Age.

The dating of the Ice Age has stimulated much field-work. The pioneer work on *varves* or seasonal deposit layers, by the Swedish geologist Gerard de Geer, showed a way of counting the number of seasons and also revealed the periods of warmer and colder summers since the Pleistocene Ice Age. De Geer established that the last glaciation maximum occurred about 14,000 years ago. In Norway H. W:son Ahlmann concluded that the Ice Age fell into two periods —the greater glaciation followed by a lesser—and that the interglacial period was characterised by the vigorous fluvial erosion and deposition which have given to the Norwegian landscape much of its present character. During the less intense second glaciation in Norway nunataks must have stood above the ice-cap.

The mountains and plateaux of Scandinavia stretch for over 1,000 miles (1,600 km.) from 59° to 71° N. and rise to 6,000 ft. (1,830 m.) in the north and to 8,000 ft. (2,435 m.) in the south. These great uplands are aligned obliquely to the rain-bearing south-westerlies and therefore have a heavy precipitation. Even a slight reduction of temperature would cause the present glaciers and snow-cap fragments to extend and coalesce. It would not require a great lowering of temperature to restore the ice-cap with a steep plunging surface to the west and piedmont glaciers to the east. The divide between eastward- and westward-flowing ice would migrate eastwards as it did during the last Ice Age when it lay some 100 miles (160 km.) to the east of the present watershed. Greenland, with the largest ice-cap remaining in the northern hemisphere, has now been explored, and knowledge of the ice conditions is leading to a new appreciation and assessment of the Ice Age and its effects. Using a seismograph Alfred Wegener, along a route running from the west coast inland to just north of 70° N., found that the ice increased in thickness until at 732 miles (395 km.) inland it was about 8,200 ft. (2,500 m.) thick. It appears from his measurements as if the surface of Greenland is pressed down into a saucer shape by the weight of the ice. If the average thickness is 3,280 ft. (1 km.) this gives a volume of one-quarter of a million cubic miles (1·83 million cu. km.) for the present land ice covering Greenland. At the close of the Ice Age the

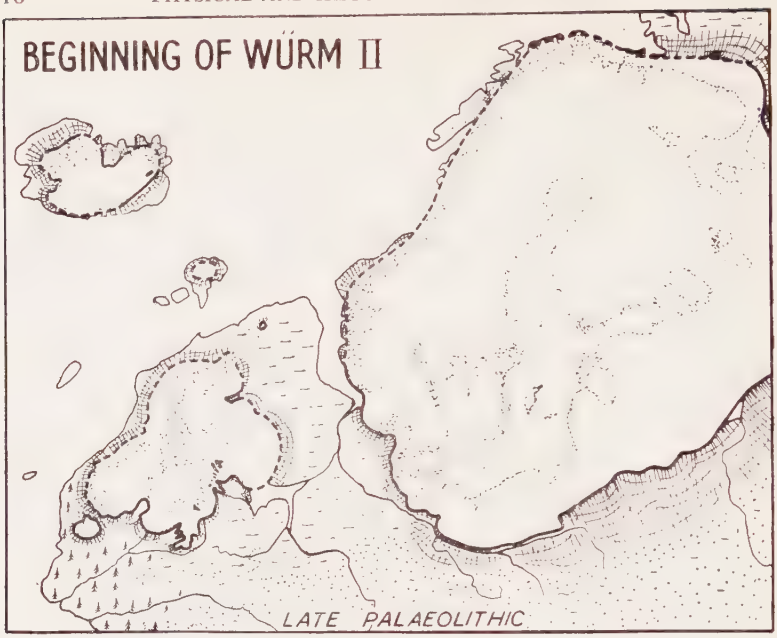


FIG. 2.—NORTHERN EUROPE BEGINNING OF WÜRM II PERIOD.

This map shows the conjectured land area and surface cover when Late Palæolithic people were living to the south of the North European Plain.

Key as for Figure 6.

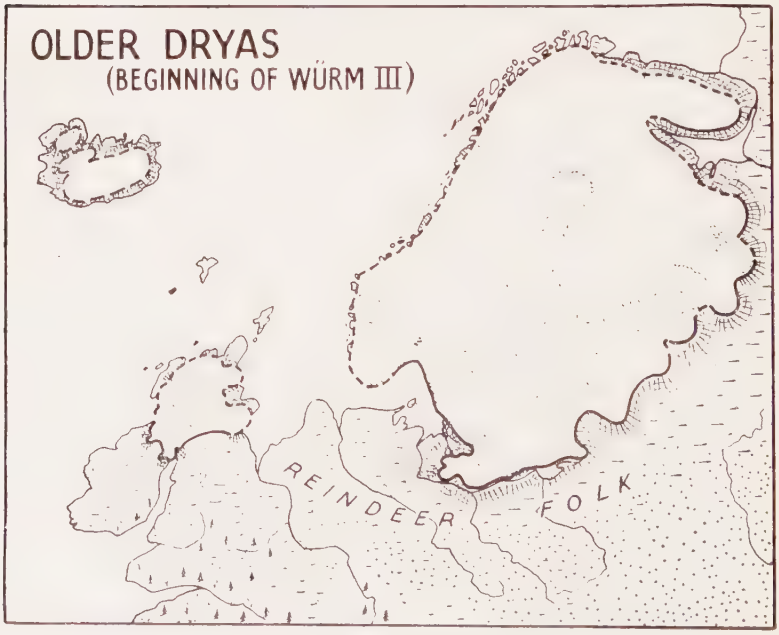


FIG. 3.—OLDER DRYAS PERIOD.

The ice has contracted and the vegetation cover has improved to allow the spread northwards of the Reindeer folk.

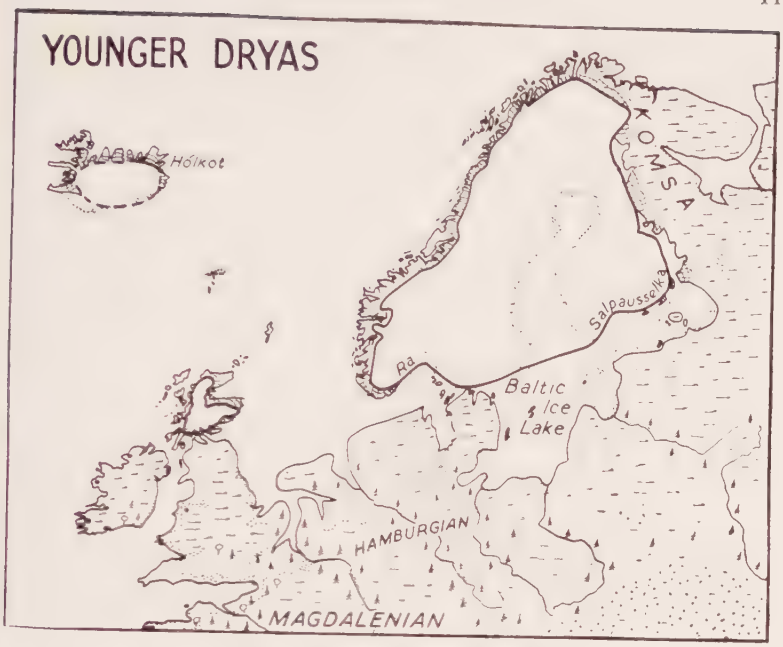


FIG. 4.—YOUNGER DRYAS PERIOD.

The ice has further retreated and at the halt, which created the Ra and Salpausselkä moraines, the Baltic Ice Lake lay to the south. Human societies were becoming more advanced and the Komsa culture had appeared on the Finnish marchlands.

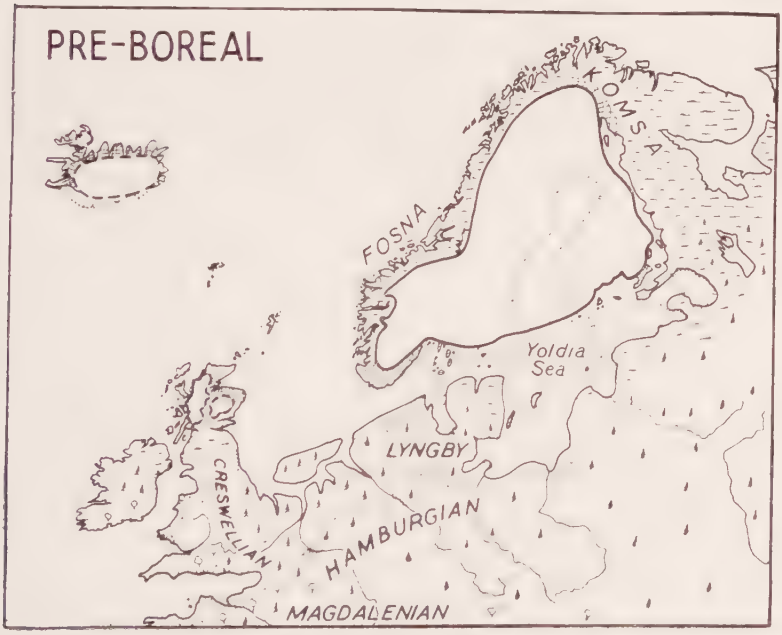


FIG. 5.—PRE-BOREAL PERIOD.

Further retreat of the ice has allowed salt-water to enter the Baltic Basin (Yoldia Sea) and has greatly extended the area where man could live.

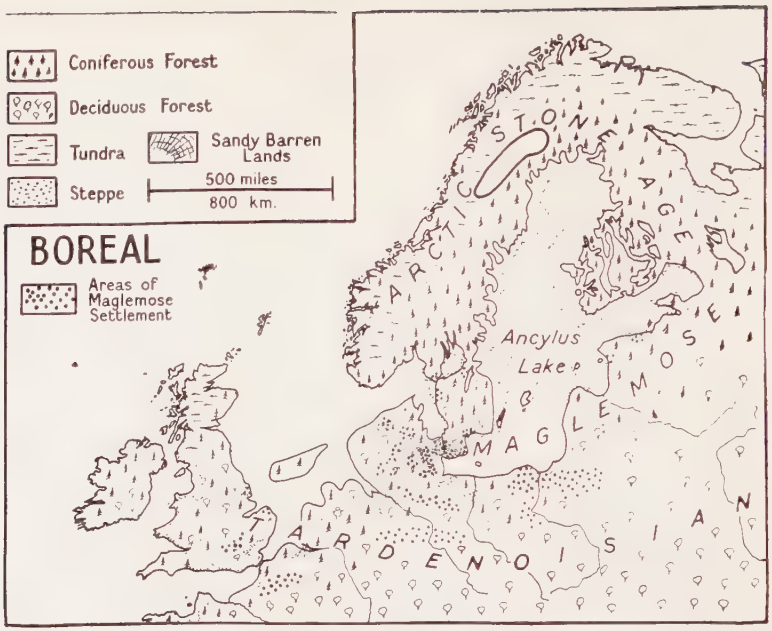


FIG. 6.—BOREAL PERIOD.

With the virtual disappearance of the ice, and the continued uplift of the land, Lake Ancylus was formed. Beside what is now The Sound are widespread remains of Maglemose culture which is contemporaneous with Tardenoisian further south.

FIG. 7.—ATLANTIC PERIOD.

Ancylus Lake has been turned into the Littorina Sea and uplift has commenced to extend appreciably the area of flat land round the Gulf of Bothnia and to expose lacustrine soils. Conifer forests are more widespread and deciduous trees have spread into central Sweden and southern Norway.

Figs. 2–7 are based on work by Daly, Zeuner, Enquist, Wolstedt, Nielsen, Clark and Thorarinsson.

region was almost wholly swamped by a thicker mass of ice than that now existing. Removal of part of the load has resulted in beach features which become higher above sea-level going north. In the south there is evidence of submergence and on the fringing off-shore shelf drowned river channels can be distinguished.

Glacier changes

The Swedish geographer Ahlmann in 1919 commenced his work on glaciers by studying the Styggedal glacier in the western part of the Jotunheim and analyses were made over successive years of the "balance" between accumulation of snow and ice and of the loss by ablation, i.e. melting and evaporation. After this initial study further precise observations were made of other glaciers in the region round the Norwegian Sea by Ahlmann and his associates. It was

FIG. 8.—GLACIER IN RETREAT NEAR LONGYEARBYEN.

The foot of the glacier, which is almost dead ice, is here choked with debris which has fallen from the adjoining hill flanks.

found that with cloudy maritime conditions rime, as well as snow, added to the accumulation of ice while ablation was due to direct radiation and to convection and condensation of water. Ablation was found to be greatest with warm and humid air and strong winds, for warm moisture condenses from the turbulent air and melts the snow or ice. Thus in the maritime areas ablation is considerable during the summers and if the ablation period is increased by, say,

warmer springs the glacier will shrink. The factors affecting growth and decay may be summarised as follows:

Convection and Radiation. In the lower altitudes convection, most important in maritime areas, can account for nine-tenths of the ablation, while in high altitudes and in extensive icefields direct radiation may be of most significance.

Temperature. This dominates the régime of the glacier and with even slightly warmer winters the snow may turn to rain and so increase the length of the ablation season.

Morphology. If there is a large accumulation area above the firn-line the glacier may still advance even if ablation increases at lower altitudes. In a plateau area a small lowering of the firn-line may greatly increase the area of accumulation.

Speed of Movement. If ablation becomes dominant the ice movement slackens while with colder conditions ablation may decrease in the gathering area and the glacier tongues will advance from the ice-cap.

For the disruption of a continental ice-sheet increased insolation is essential until the ice-mass thins sufficiently and the firn-line becomes higher, so that the accumulation area is reduced.

During the period of maximum glaciation the snow-line was much lower than at present, and the lowering became greater farther south.

Height of snow-line

	Latitude	*Snow-line*	
	° *N.*	*ft.*	*m.*
Spitsbergen	76	1,640	500
West Greenland	75	2,625	800
Iceland	65	1,970–3,280	600–1,000
Norway	60	5,250	1,600

GLACIATION EFFECTS

Upland. In Norway the ice-streams were forced along narrow, pre-glacial valleys aligned in the highland along lines of tectonic weakness. Here the ice was thicker and faster moving than in the less confined ice-streams to the east so that the erosive power was greater and the removal of debris more rapid. As the tongues of ice proceeded down the valley below the snow-line sub-aerial erosion would be active on the uncovered slopes. Where there was a larger gathering ground, as a result of the Tertiary river pattern, the glaciers would coalesce at the outlet valley and there, as in Sognefjord, excavate deeply.

Glaciers which headed in corries have broken the mountain masses and produced on the edge of plateau areas a sharp relief, the profile of which varies according to the nature of the rock. In Iceland can be recognised incipient corries which develop when snow lingers and the melt-water carries fragmented debris downhill so that the hollow holding the snow enlarges.

Lowland. In the advance of the ice great trains of boulders were taken southwards and where there are outcrops of distinctive rocks, such as the granites of the Åland Islands or of Tammela in Finland, the lines of movement across the lowlands can be identified. The advance of the ice-sheets brought vast volumes of material forwards and it was spread as boulder clay or as fluvio-glacial material across the lowlands; but the more distinctive landforms are associated with

FIG. 9.—BROAD U-SHAPED VALLEY.

Cut by meltwaters into the nearly horizontal rocks near Borg, Iceland, are broad valleys which are now ill-drained.

the retreat of the outer edge of an ice-sheet or glacier, for in the advancing stage the features are obliterated.

The principal landforms left after retreat of the ice are eskers, terminal moraines and drumlins. Eskers (Swedish *ås*, Finnish *harju*) are long ridges resembling railway embankments which were formed by running water within the ice-sheet and near its edge; they were approximately at right-angles to the ice-front and were extended backwards—that at Uppsala can be traced for over 100 miles (160 km.)—as the ice retreated. Masses of dead ice were caught in the deposits and kettle-holes were formed on the surface and alongside while on the decay of the enclosing ice the sides slumped to the

angle of rest which, for coarse sands and gravels, is about 30°. Subsequent marine erosion may have reworked the sands and gravels at the top of the esker and also the sorted material deposited on the flanks.

The terminal moraines which stretch across southern Finland (*Salpausselkä*), Sweden and Norway (*Ra*) are great masses of mixed sand and clay deposited partly from ice and partly from fluvio-glacial rivers.

Drumlins occur on the inner side of some of the greater terminal moraines, producing a characteristic corrugated landscape with low rounded ridges rising above wetter hollows.

Interspersed with the glacial deposits are lacustrine beds representing the sites of former lakes, whilst fringing the Baltic and its gulfs are marine deposits now exposed by uplift.

Not all the glaciation effects in a lowland are of deposition and the thin sheets of ice moving across a lowland area, as in south-eastern Norway, could erode the less resistant rocks and produce a varied relief with "crag-and-tail" and *roches moutonnées*.

LAND UPLIFT

Under the great mass of the North European ice-cap, which was of the order of 10,000 ft. (3,000 m.) thick, the land became depressed by some 1,640 ft. (500 m.) near the Gulf of Bothnia, compared with 130 ft. (40 m.) at Ålesund. There was also an interference with the datum of sea-level: the water fixed in this extra snow and ice has been estimated to have shallowed the oceans by some 246–295 ft. (75–90 m.). The mere presence of these great ice masses would by gravity attract the ocean waters and so lead to a further reduction of sea-level elsewhere than near the ice-sheets. As was first realised by the Scottish geologist T. F. Jamieson in 1882, under the weight of ice the land surface would be unevenly depressed and after removal of the load there would be isostatic readjustment which, in conjunction with the eustatic change, as the ocean waters increased in volume, would give emergence features to the shores following the initial submergence as sea-waters flowed over surfaces once covered by ice. Nowadays the depression resulting from the ice-cap has been largely eliminated and has almost counteracted the temporary flooding which followed when the melt-waters raised the sea-level. Eustatic change could also result from uplift of the bottom of the coastal seas, which would drain some of the water off the continental shelf and so increase the volume of the oceans proper, while sedimentation of coastal waters would have the same effect. The adjustment was not even and smooth but took place by stages which can be

distinguished by strandline features. This uplift of the land is still continuing, although at a reduced rate of about two-thirds of the average, and has its maximum of about 0·4 in. (1 cm.) a year between Luleå and Umeå, on the Bothnian shore. In Spitsbergen the post-glacial uplift has been at least 164 ft. (50 m.) while in Greenland it varies from nothing in the south to several hundred feet in the north.

Much of the investigation into changes of sea-level and of post-glacial uplift has been carried out in Finland where a correlation has been made between tide-gauge readings and geodetic measurements. The complexity of the problem is increased by this alteration in the datum.

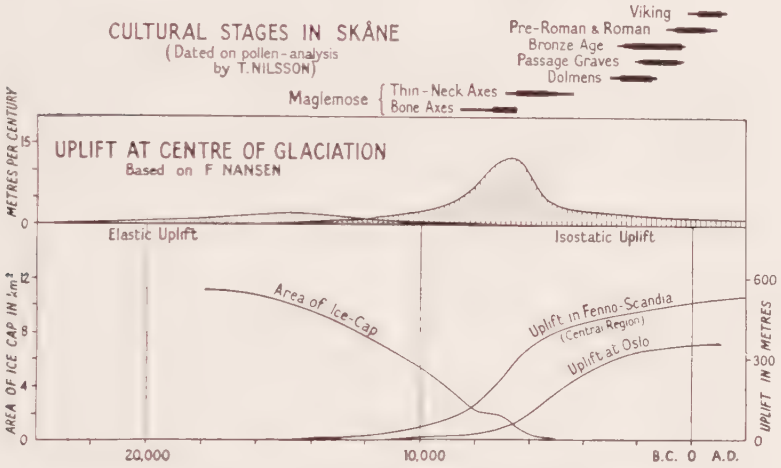


FIG. 10.—GEOCHRONOLOGICAL DIAGRAM.

The lower diagram indicates uplift following reduction in the mass of the ice-cap; the upper the associated culture stages in Skåne. For *elastic* read *eustatic*.

Contours known as *isobases*, based on the beach datum and joining points of equal uplift, show that post-glacial warping has domed the surface and that the greatest uplift is where the load of ice was greatest. The isobases are concentric round this area of greatest load and the outer limit of uplifted land, the "hinge-line", parallels the limits of glaciation. If a marine beach be traced inwards it is found that there are bends in its longitudinal profile, a proof of the discontinuity of uplift and of the warping which has occurred.

Noteworthy features of the longitudinal profiles of rivers which originate in ice-caps are the breaks of slope, and also the braided lower courses which represent the sections where the gradient slackens and the fluvio-glacial load of the river is deposited. Such a zone of deposit occurs near the edge of glaciers and ice-sheets where

the outflowing water is overloaded. Such breaks of grade therefore do not represent a warping uplift.

Uplift has had an effect upon human occupancy, as in the

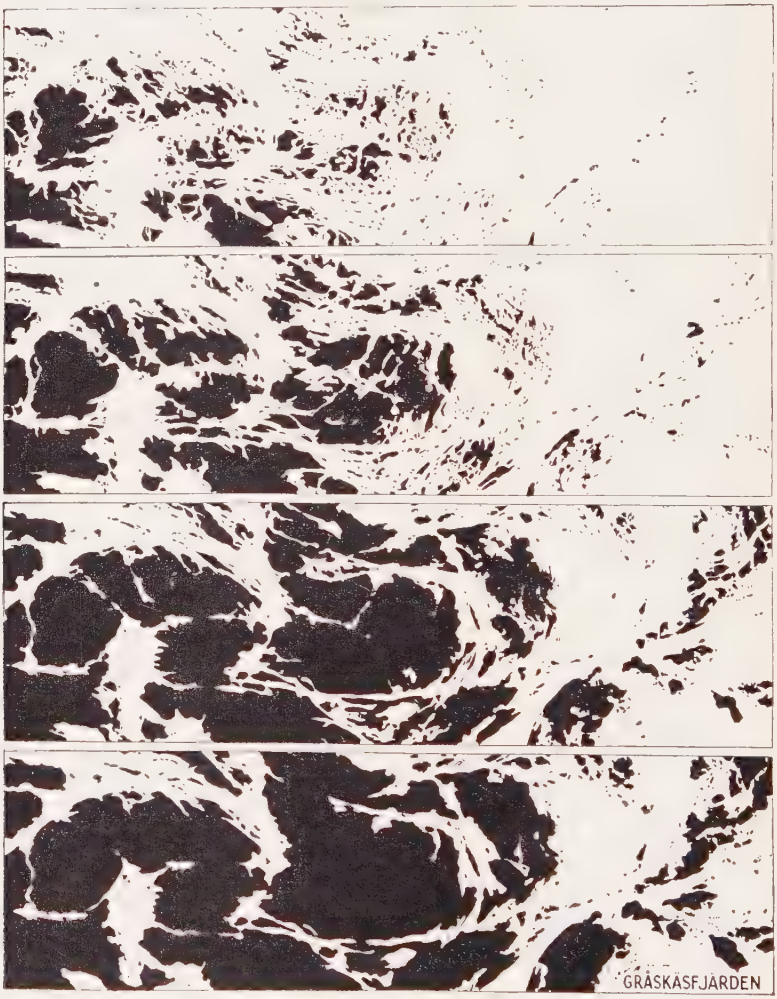


FIG. 11.—UPLIFT IN THE STOCKHOLM SKÄRGÅRD.

The four maps cover the same territory [8 miles (12·8 km.) by 27·2 miles (43·4 km.)] in the southern part of the skärgård. The land surface is in black for each period—the top map at the end of the Stone Age, the second the latter part of the Bronze Age, the third at the Viking Age and the bottom the contemporary land area.

Based, with permission, on B. Hedenstierna, "Stockhoms Skärgård", *Geografiska Annaler*, 1948, Plates 1, 2, 3 and 7.

shallowing of ports in northern Sweden and in Finland. A rise of 36 ft. (12 m.) would close all the channels between Jylland and Skåne and there would be a reversion to the land bridge which existed at the time of the Ancylus Lake: such a contingency is remote in this now almost stable area, for there is a balancing eustatic rise of ocean level of about 2½ in. (6·5 cm.) each century due to ice melt. However, in the area which had the greatest load of ice there is still a rise required of some 650 ft. (200 m.) to restore the original equilibrium: the effect of this on the Gulf of Bothnia would be virtually to drain it out.

THE COASTS

The general character of a section of the Scandinavian coasts is

FIG. 12.—COASTLINE TYPES OF SOUTHERN SCANDINAVIA.

This sector of the Scandinavian coasts illustrates most of the features found and also shows the deep water close to the southern shore of Norway.

Based on local charts and maps and strandflat from F. Nansen, *The strandflat and isostasy*, Kristiania, 1922.

given in Figure 12 and from this can be seen the great variety which occurs between the smooth, emergent coastline of northern Jylland and the ice-scraped shores of western Norway. This zone of contact between salt water and land has been one of the most vital in moulding the history of this northern area. Despite the variety within the coastal zone certain features, many the result of glaciation, are reiterated, and these give the region its character.

THE STRANDFLAT

Bordering much of the coast of Norway is a set of three beaches, known as the strandflat, carved in the rock with inner edges about 25 ft. (8 m.), 50–60 ft. (15–18 m.) and 100–130 ft. (30–40 m.) above the present sea-level. The well-known cave-tunnel on Torghatten Island, 400 ft. (120 m.) above sea-level also marks a former level of the island in relation to the sea. Much of the Scandinavian coast was originally covered with drift but the lower zone has been stripped by wave action; this serves to indicate the amount of uplift since the drift was deposited and it is found that these beaches, by a process of warping in the uplift, tilt away from the centre of glaciation, whereas the strandflat is essentially horizontal.

The problems of the strandflat attracted the attention of Fridtjof Nansen who published in 1922 an *exposé* of the features and of suggested explanations and his survey forms a landmark in geomorphological studies. Nansen argued that, with little evidence to show that ice could be a powerful erosion agent on low land, there must have been abnormal sub-aerial action. He considered that the low temperatures prevailing during the inter-glacial and post-glacial periods would result in rapid rock erosion by frost action and that, with the various shifts of sea-level, strandflat features at different heights would be developed.

The strandflat must have been largely formed by marine erosion, coupled with abnormal sub-aerial erosion, in the interglacial period. It was later modified by glaciation, and by post-glacial marine erosion which has long acted on the same horizontal zone. Isostatic uplift along the sections of the Norwegian coast which have a well-developed strandflat has been but slight.

FJORDS

The fjord coasts of Scandinavia offer a foothold for settlement where harvests can be drawn from the sea as well as the land. Furthermore their beauty, while sometimes monotonous, has greatly helped the development, in the more favoured districts, of a valuable tourism.

A fjord is an arm of the sea, with steep sides and a trough-like floor which is often shallow near the threshold, and which frequently continues inland as a valley and may extend seaward as a trench cut into the continental shelf. Tributary fjords to a main one are always at a sharp angle to the principal fjord and the side valleys, cut in the dissected plateau, "hang" to the fjords. The true fjord exists along the drowned edge of a glaciated upland and so it is well seen in the Scandinavian World.

Norway has along its western coast many examples of true fjords; the so-called fjords of the Arctic coast are not set in a highland, and the characteristics of fjord terrain may best be studied in the stretch of coast between Hardanger and Nord fjords. Sognefjord is the longest in Norway, 112 miles (180 km.) from the sea to the head and its greatest depth is some 4,000 ft. (1,220 m.) for the floor plunges deeper than the offshore sea floor. In the same way Hardangerfjord has greater depths than the adjoining sea. These fjords are cut into a plateau along the lines of pre-glacial river valleys, which frequently coincide with fault lines, and the absence of spurs at the foot of the confining hillsides is a result of glaciation.

Into the young plateau of Spitsbergen, in pre-glacial times, rivers cut valleys along the fault zones. By the movement of the ice-cover these fault zones have been moulded into fjord valleys, set in the plateau. Iceland has a coastline broken by many short fjords and some of them have the characteristics of the tapering so-called fjords of the Arctic coast of Norway, but many, which continue as a trench towards the deep oceanic waters, have a true threshold. Faulting produced lines of weakness which were eroded in pre-glacial and interglacial times as valleys in which the ice-sheets were thicker.

Greenland has a varied coastline: large fjords exist on the north-east coast and smaller fjords on the south-east and south-west coasts. Fjords do not occur in the central section of the east coast and there are but few on the west coast north of 72° N., but fjords reappear on the north coast. Not all the so-called fjords have threshold sills and again there is a resemblance to the Arctic coast of Norway. Gregory believed that many of the fjord valleys of Greenland were aligned along fault-lines which had been eroded by pre-glacial streams and that these valleys were later followed by glaciers.

FJARDS

Along the rocky Swedish shores of the Baltic occur inlets with many of the characteristics of fjords yet, the land being low, there are no steep sides to the valleys. Again the valleys have been cut by

pre-glacial streams but have been widened out and slightly over-deepened by ice. In the lowland areas in Spitsbergen, formed of less resistant rock, the drowning of the valley ends has produced a fjard, rather than a fjord, coast.

FØHRDE

This term from Schleswig has been adopted to describe the drowned valleys of Denmark, although in that country in the place-names occurs the form "-fjord". These drowned valleys, formed in an area of glacial deposition, are not usually estuaries, for the streams which enter are very minor and they are formed in unconsolidated material which is readily removed to form a bar across the mouth. This bar bears a superficial resemblance to the threshold of a true fjord.

OFF-SHORE BARS

On the west coast of Jylland the dangerous Horns Rev runs southwards at an angle to the coast. This reef represents the line of a drowned moraine. Along the south shore of Iceland for over 200 miles (320 km.) extends the great concave curve of an off-shore bar formed of fine gravel and sand and occasionally, of shingle. Only rarely is the bar broken and of the gaps one of the largest is at the entrance to Hornafjörður.

CHAPTER 3

CLIMATE

The principal factors affecting the climate over much of the Scandinavian World are the great latitudinal spread, the presence of a great mass of warm water to the west and a much lesser water area to the east, the existence of an area of high relief to the west of the Scandinavian peninsula and the fact that many of the air masses are coming from the west with cyclonic characteristics. The whole area, apart from Greenland, experiences the interplay of air masses with different physical characteristics—cool, unstable air (Maritime Polar), warm, moist air (Maritime Tropical) and dry air from the Eurasian interior (Continental Polar).

GENERAL CONDITIONS

In the southern part of Sweden and in Denmark the low elevation interferes little with maritime influences. In Norway the relief barrier retards the warm front on the ground, but the warm air overrides the layer of colder surface air and so the warmth is not

A.C.O.] [*July, 1932*

FIG. 13.—WIND EFFECT ON TREE GROWTH NEAR MALMÖ.

Strong westerly winds which carry salt over the land can blight vegetation in the coastal strip.

felt on the ground, east of the mountains. Conversely continental influences extend across the Baltic and its gulfs as far west as the mountains; such conditions do not usually last long, but they can bring cold spells which seriously affect farming activities. The various air masses and features which affect climatic conditions in Scandinavia may be grouped as west maritime (Atlantic), East Sea maritime, Continental (Russian) and local.

West maritime influences are experienced both from the drift of warm water and from the conflicting cold and warm air masses along the polar front. Most fronts have become occluded when they reach the mountainous land of Norway and the warm air, separated from the ground by a layer of cold air, brings precipitation in Sweden without affecting temperature conditions. At the break in the mountains between Trondheim and Jämtland warm air can cross without occlusion of the front. In the early winter the land round the Skagerrak is rapidly cooling and the sea water retains its heat; locally originating depressions thus develop, secondary to the main depressions which have passed from Iceland to Norway, and these Skagerrak depressions bring heavy precipitation, often as sleet and snow.

Johansen and Jensen drew a correlation between the currents of the coastal waters of Denmark and the weather of the adjoining land. They noted that a high salinity during the spring in the lower parts of the northern Kattegat was normally followed by a low air temperature in June and July and vice versa. The reasons suggested by these writers were that a high salinity in the lower parts is due to a strong inflow which results in low temperature in the surface layers and this affects the air temperatures of the surrounding lands.

Frequently the depressions of autumn and early winter which have crossed southern Sweden move slowly over the Baltic and draw into the low-pressure centre cold air from Finland or northern Russia: these depressions, which are in a dying stage, bring frost into central Sweden. The East Sea maritime air has a considerable influence on the climate of both Sweden and of Finland except when the sea is frozen over: the Gulf of Bothnia is free of ice for six months and the period lengthens southwards (see p. 48). The moderating influence is greatest within the limit of the sea breezes and in this coastal zone springs are delayed and autumns prolonged, but unfortunately the amelioration value is reduced by Arctic air being able to neutralise any of this maritime influence and so killing frosts are as frequent as in more inland places. Depressions which halt over the East Sea in summer bring rain which may be of value to farmers.

Continental air masses from Russia flow over the Baltic Shield area in late winter and early summer and bring cold, dry air; these

air conditions may persist over Scandinavia as far west as the mountains of Norway.

Local influences on the climate are dominated by the mass of highland in the Norwegian fjells. Here is a barrier to the penetration eastwards of maritime air, while the southward movement of bitterly cold Arctic air masses is assisted. Not only does this result in cold winters but it reduces the length of the growing season by delaying the arrival of spring.

Conditions vary of course from year to year; when western maritime (Atlantic) air penetrates eastward the winters are mild, with a heavier precipitation, and summers are cooler compared with the more stagnant conditions which occur when the area is dominated by continental air.

Attention must be paid to Arctic air in any review of climatic conditions in the Scandinavian World. After a century of broken observations made by various expeditions consecutive records are now available, and on the earliest of these and on observations from pilot balloons Hobbs evolved his theory of *glacial anticyclones*, which was inspired by Peary's statement about winds above the inland ice: "Except during atmospheric disturbances of exceptional magnitude, which cause storms to sweep across the country against all ordinary rules, the direction of the wind of the 'Great Ice' of Greenland is invariably radial from the centre outward, normal to the nearest part of the coastland ribbon. So steady is this wind, and so closely does it adhere to this normal course, that I can liken it only to the flow of a sheet of water descending the slopes from the central interior to the coast."[1] Earlier explorers, such as Nansen, had also noticed this phenomenon, and Hobbs postulated a theory which demands first that the surface of the ice be domed and second that the air, cooled over the ice-dome, should slide outwards, drawing down fresh air from above which is cooled in its turn, thus producing anticyclonic conditions which persist until the movement ceases as the air, thermodynamically warmed in its descent, is no longer cooled sufficiently by contact with the ice surface. There is frequently found over the ice above the cold air a layer of warmer air which by strong winds may be brought to the land level.

These dry föhn-like winds which may reach blizzard force were noticed in *The King's Mirror* written *c.* 1240 A.D. and also in some detail in Rink's classical work on *Danish Greenland* (English translation, 1877). Rink observed that when the outblowing wind approached blizzard force it overrode the variable coastal winds and this feature has been confirmed by pilot-balloon observations.

[1] R. E. Peary, "Journeys in North Greenland," *G.J.*, 11 (1898), p. 233.

Above Greenland air movement, as shown by high clouds, is inwards to the "eye" of the anticyclone.

V. Bjerknes and his son J. Bjerknes, in their classical work on temperate latitude cyclones, demolished the original concept of Ferrel that there was low atmospheric pressure at the poles. Later

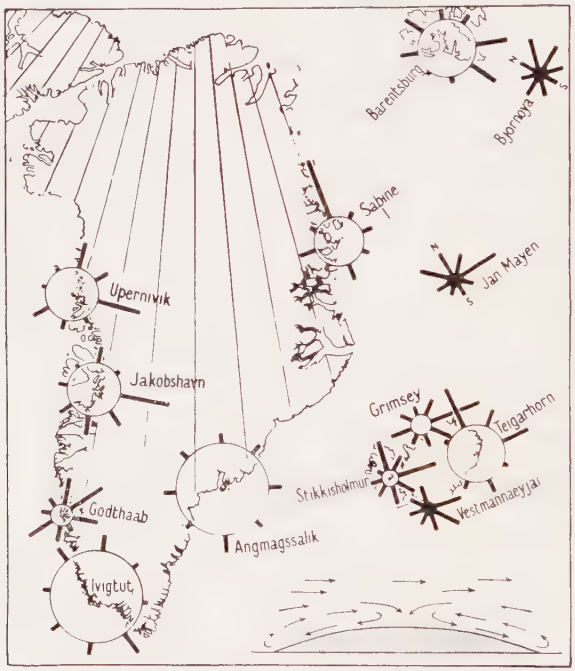


FIG. 14.—WINDS IN THE NORTH-WEST ATLANTIC AND GREENLAND.

The circles are proportional to calms recorded and the lengths of the rays to the percentage of winds from each of the eight main directions—N., N.E., E., etc. Longitude lines are drawn in over the land areas and wind directions should be read from these as giving the true north–south alignment. In the bottom right-hand corner is a view of the wind movements over the Greenland ice-cap as postulated by Hobbs (p. 25 and p. 32).

Based on wind data in *Arctic Sailing Directions*, 1934.

observations have shown that the Greenland ice-cap in some respects acts as the air-pole and here air of tropical origin sinks before radiating out as cooled air to have an irregular zone of contact with surface air coming from the tropics as prevailing westerlies. There seems to be little doubt that some of the depressions which affect northern Europe originate in Greenland while others which

originate to the south-west are reinforced by this "polar air" from over Greenland. Rink noticed that the strong föhn-like winds on the south-west of Greenland occurred with the passage of depressions along that coast.

TEMPERATURE

Lying on the western shores of the world's largest landmass and receiving a portion of the heat of the North Atlantic "Gulf of Winter Warmth", the more settled part of the Scandinavian World has temperatures much higher than the mean for the latitudes concerned. Even in Finland the benefit is over 9°F. (5°C.) in January while in the Lofoten Islands it is about 45°F. (25°C.); the less critical July figures are about 7°F. (4°C.) and 4°F. (2°C.) respectively of positive anomaly. The following table illustrates the variation which occurs for four Swedish stations, with temperatures reduced to sea-level, as compared with the mean sea-level temperatures of their respective latitudes.

Temperatures illustrating positive anomaly, in °C.

Latitude Zone	*Place and Latitude*	*January*	*April*	*July*	*October*	*Annual*
55°	Mean	−10·9	1·2	15·7	3·6	2·3
	Lund 55° 42′	−0·6	5·5	16·7	8·1	7·4
60°	Mean	−16·1	−2·8	14·1	0·3	−1·1
	Stockholm 59° 21′	−2·7	3·6	17·0	6·4	5·9
65°	Mean	−22·5	−8·4	12·2	−4·5	−4·3
	Stensele 65° 4′	−10·9	1·1	15·9	1·8	1·5
70°	Mean	−26·3	−14·0	7·3	−9·3	−10·7
	Karesuando 68° 27′	−13·3	−2·7	14·4	−1·2	−1·2

[Based on A. Wallén, *Climate of Sweden*, 1930, p. 13.]

Regional differences of temperature show the transition from maritime to semi-continental conditions and in Sweden particularly conditions in adjoining territories influence the temperatures experienced. Opposite the Storlien col winter temperatures are highest, whereas to the north, where the land link with Europe is broad and of low relief and little amelioration is obtained from the Gulf of Bothnia, cold easterly continental influences are dominant, and to the south where southern Norway and northern Svealand

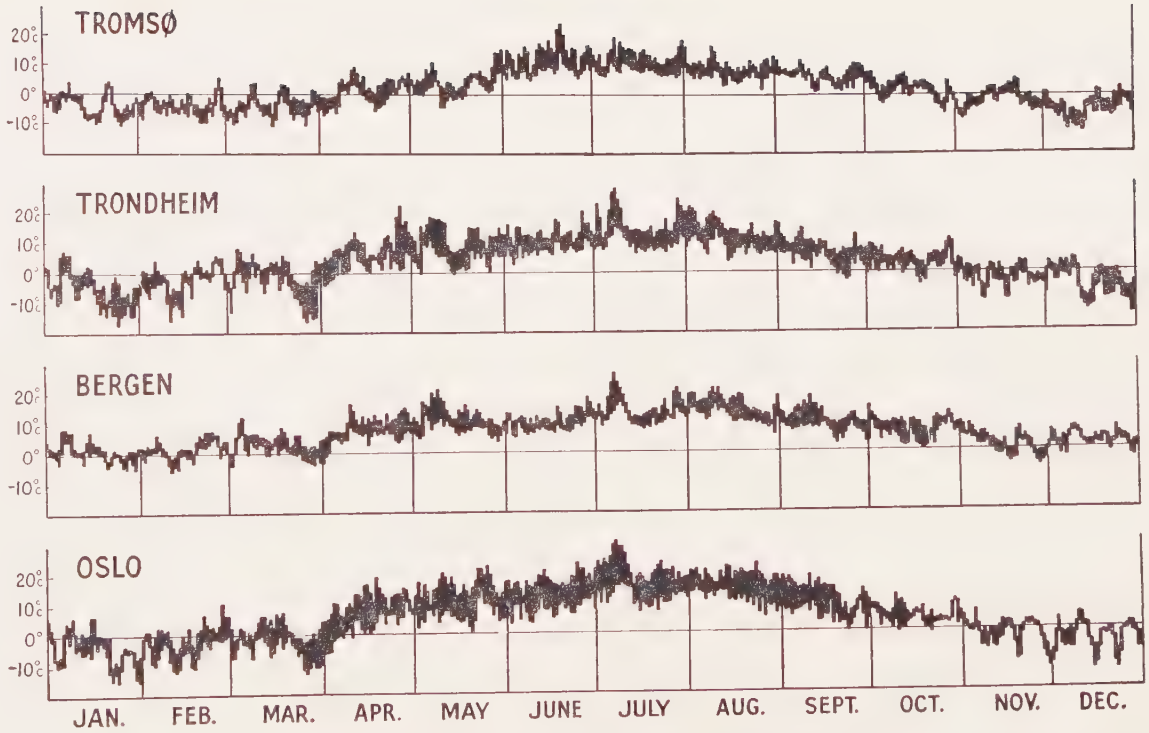


FIG. 15.—THE MARCH OF TEMPERATURE IN NORWAY, 1952.

The maximum and minimum temperatures for each day in the year are plotted for these four stations. The difference, in both diurnal and annual range, between the more continental weather of Oslo and the maritime west is clearly seen. Temperature range is also greater in the more northerly stations.

Based on *Norsk Meteorologisk Årsbok*, Oslo, 1953, pp. 16–39.

are high and broad the maritime influence is reduced. Temperatures are much mellowed by the proximity of warm water and this, while most clearly distinguishable at places alongside the North Atlantic Drift, is also appreciable beside the southern Baltic where, in Sweden, the modified temperatures contrast strongly with the more extreme conditions experienced on the Smaland plateau. In the Færoes there is a slight range of temperature through the year: the springs are long and cold, March is as cold as January, the maximum occurs in July and August and there is a long autumn characteristic of maritime conditions.

Daily variation of temperature has been analysed for a number of Scandinavian stations and it is found that the diurnal range is less in autumn and winter than in spring and summer. The periodic 12-hour variation which occurs at high altitudes is believed to be due to regular daily changes in wind direction. According to Hamberg, writing as early as 1897 and quoted by Ångström (1932), at Stockholm maxima in winter are due to tropical air brought in by southerly winds, and very low temperatures to continental polar air brought in by north and north-east winds and less severe cold by maritime polar air brought in by north-westerly winds. In eastern Scandinavia quite large diurnal ranges may occur.

Extremes of temperature are greatest in the more continental areas: for example at Sveg in Sweden (latitude 62° 02′ N.) on 14th February, 1881, a temperature of −56° F. (−49° C.) was recorded; but of much more significance are the days in the year when frost is experienced and vegetation growth is at a standstill. In the northern part of the Norrland area of Sweden on an average there are 150 days in the year when the *maximum* daily temperature is below freezing point.

Temperatures at particular stations are affected by their location: lakes near by raise the temperature in autumn and winter and lower it in spring and summer; forests slightly lower temperatures in summer and increase them in winter while, of course, in areas of steep relief the aspect and angle to insolation can be of major significance both in the amount of energy received and in the formation of cold pockets and temperature inversions.

PRECIPITATION

No part of Scandinavia is arid, although in certain sandy areas plants may find difficulty in obtaining sufficient moisture for full growth in average, as well as dry, years. Departure from the normal, as a percentage of the mean, is least in western Norway where there is no appreciable danger of drought conditions arising and is greater

in the drier areas where it may be critical for crop and hay production. As an example of the variations which may occur even in a wet area the following table shows the extremes for the meteorological station of Samnanger in the Tysse valley of western Norway situated 1,214 ft. (370 m.) above sea-level.

Precipitation extremes at Samnanger, 1901–43

Period	*Driest*			*Wettest*			*Mean*	
	Year	*in.*	*mm.*	*Year*	*in.*	*mm.*	*in.*	*mm.*
January	1941	1·1	29	1925	31·9	818	15·6	400
February	1929	1·3	34	1943	31·9	818	10·9	280
March	1909	0·7	19	1938	38·5	988	9·9	251
April	1918	0·08	2	1943	26·0	667	6·1	156
May	1935	0·3	8	1922	23·5	602	5·3	136
June	1933	1·1	28	1931	17·1	438	8·4	166
July	1913	1·6	40	1928	21·7	557	7·4	190
August	1931	1·9	48	1909	22·5	576	10·5	269
September	1936	3·4	86	1917	32·8	842	12·1	311
October	1920	0·7	19	1942	30·7	786	12·9	332
November	1910	1·9	48	1938	22·7	581	12·3	316
December	1927	0·3	8	1936 1941	28·7	737	13·0	335
Year	1915	77·2	1,982	1921	198·3	5,087	122·5	3,142

[Based on *Nedbøren i Norge*, Tables 3 and 16

It will be noticed that the driest year and the wettest year have attained their distinction by a series of drier or wetter months respectively than by experiencing the extremes in any one month.

In the Scandinavian World, excluding Greenland and the Arctic islands of Norway, rain-bearing cyclonic winds are mainly from the west and as the moisture is forced from the air by mountains the windward side is the wetter. The leesides, including the northern part of Gudbrandsdalen, receive under $15\frac{1}{2}$ in. (400 mm.) a year as a result and so have less than one-eighth of the average precipitation received at Haukeland in western Norway (130·5 in., 3,346 mm.). Many stations in western Norway have in the single wet month of January as heavy a fall as the east receives in a year. Since the rainfall is a response to orography the maximum fall is not on the coast but some 30 miles (40–50 km.) from the coast where the effect of the increased altitude is fully experienced.

The number of rainy days, which may greatly affect agricultural practice over the drying of crops, varies considerably over Scandinavia. Along the coastal fringe of Norway it may reach two days out of three with rain.

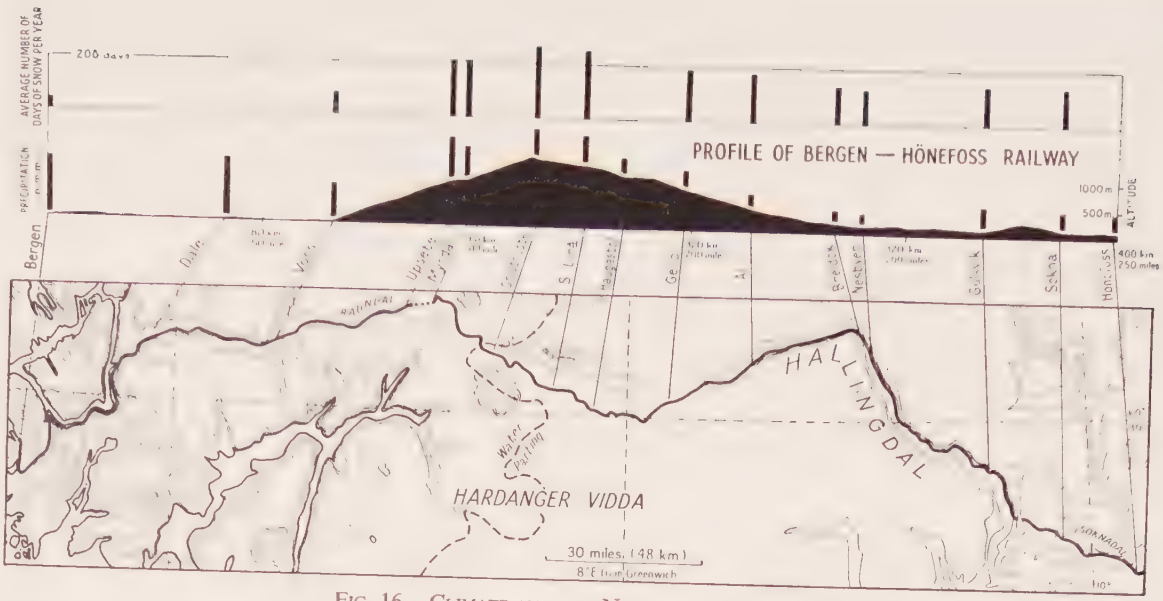


FIG. 16.—CLIMATE AND THE NORWEGIAN WATER-PARTING.

The railway profile is in black and superimposed are columns proportional to the precipitation—Dale 91 in. (2,313 mm.) rain. The upper columns represent the average number of days with snow. The influence of the mass of upland on rain and snow is clearly demonstrated with Hallingdal relatively dry but much more liable to snow than the coastal zone. Contours at 200, 500 and 1500 m. (656, 1640 and 4920 ft.).

Based on railway profile supplied by Norwegian State Railway and *Nedbøren i Norge, 1859–1943*, Table 11.

According to Ångström, a maximum of precipitation occurs in the early afternoon at inland stations and in the early morning at coastal stations in western Europe: the intermediate position of Stockholm is reflected in its rainfall characteristics. Intensity of fall varies also according to geographical location: in Western Norway very wet days occur as a result of steady rain experienced from cyclonic fronts. The heaviest day's precipitation so far measured in Scandinavia occurred at Indre Matre in Skånevik on 26th November, 1940, when 9·0 in. (230 mm.) fell in the twenty-four hours. By contrast in south-eastern Norway and in Sweden, where the heaviest falls occur with summer showers of convectional rain, the precipitation is less. While there are very wet days they do not include the days of greatest intensity of precipitation for which the Norwegian record is at Tana in Finmark where on 3rd July, 1916, in a short, sharp shower 0·2 in. (4·67 mm.) fell each minute which compared with 0·006 in. (0·16 mm.) a minute for the continuously wet day of 1940 at Indre Matre.

Snow

The thickness of the snow cover increases inland and with height above sea-level and any deep valleys stand out on a map of snow thickness as being areas of less snow for they have less fall and are warmer than the surrounding hills. The number of days with snow increases away from the actual coastal zone and may, in the higher land of the interior and in the north of the peninsula, attain over 200 days of snow cover in a year.

Where cyclones do not penetrate the snowfall is slight and may be kept as a thin cover in winter by strong winds. Over Greenland, by Hobbs's theory, the ice-dome is fed with fine snow from the precipitation of the minute ice spicules, which form high cirrus clouds, and have been brought to the ground surface by the strong down-flowing air currents in the "eye" of the glacial anticyclone. On the other hand some writers, such as A. de Quervain, believe that there is some penetration of cyclones over Greenland and that these are responsible for the precipitation.

In the southern part of the Scandinavian peninsula and in Denmark railway traffic is only blocked by exceptional snowstorms, whereas in northern Sweden snow can lie for six months and can be deep if the prevailing winds happen to be from the east as occurred in the winter of 1935–6. During normal years the Storlien col, between Trondheim and Östersund, admits warm maritime air from the Atlantic area into Sweden, and so a zone of thinner snow stretches across to Härnosänd. To the south the fall is greater, but further

south still it again decreases and is normally thin and of little significance south of Stockholm.

Fog

Where the relatively warm waters of the North Atlantic Drift impinge against cold air from the Arctic lands fog is persistent. Sea fog occurs in the coastal fringe of Norway particularly in the spring and summer, while fog resulting from cooling by radiation from land surfaces occurs in south-eastern Norway in the autumn and winter. Fogs can persist for days on end under certain conditions.

CLOUDINESS AND SUNSHINE

The latitudinal position of the Scandinavian lands reduces the amount of insolation to about one-third of that received at the equator despite the long hours of sunshine in the summer. The

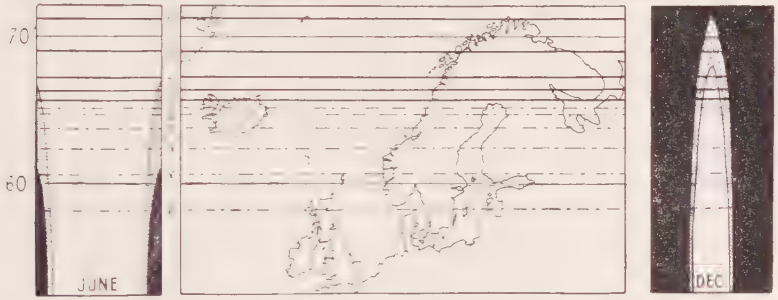


FIG. 17.—LATITUDE AND LENGTH OF DAYLIGHT.

Heavy horizontal lines with arabic numerals represent, on the central diagram, the number of days with midnight sun and the broken lines, with roman numerals, represent the number of hours that the sun is below the horizon on June 22nd. In the side diagrams black represents night and the stipple twilight for the longest day in June and the shortest day in December.

length of day gets progressively longer northwards in summer and shorter in winter and this feature, together with the reduced angle of the sun's rays, is shown in the following table.

Length of Day

Latitude	*Mid-Summer*			*Mid-Winter*		
	(*a*)	(*b*)	(*c*)	(*a*)	(*b*)	(*c*)
69°	24·00	24·00	44·5°	0·00	4·66	−2·5°
65°	21·56	24·00	48·5°	3·20	6·22	1·5°
60°	18·49	22·10	53·5°	5·42	7·43	6·5°
56°	17·36	19·46	57·5°	6·46	8·26	10·5°

(*a*) Length of day in hours and minutes.
(*b*) Length of day, together with dawn and twilight periods in hours and minutes.
(*c*) Greatest altitude of sun at solstice.

[Based on A. Wallén. *Climate of Sweden*, 1930, p. 10.]

The summer abundance of light is an advantage for life, particularly in the continental areas, where cloud is at a minimum, and as a result Jokkmokk, in Sweden, has more hours of sunshine in June than occur at Rome.

In addition to the humidity derived from maritime air the numerous expanses of fresh water increase the atmospheric humidity and result in cloudier skies which are, in part, an advantage for they delay heat radiation from the land surface.

SEQUENCE OF WEATHER AND THE SEASONS

Perhaps the most striking characteristic of the Scandinavian seasons is the length of the winter followed by a relatively hot summer. In winter the centres of cold are in Lapland, and as

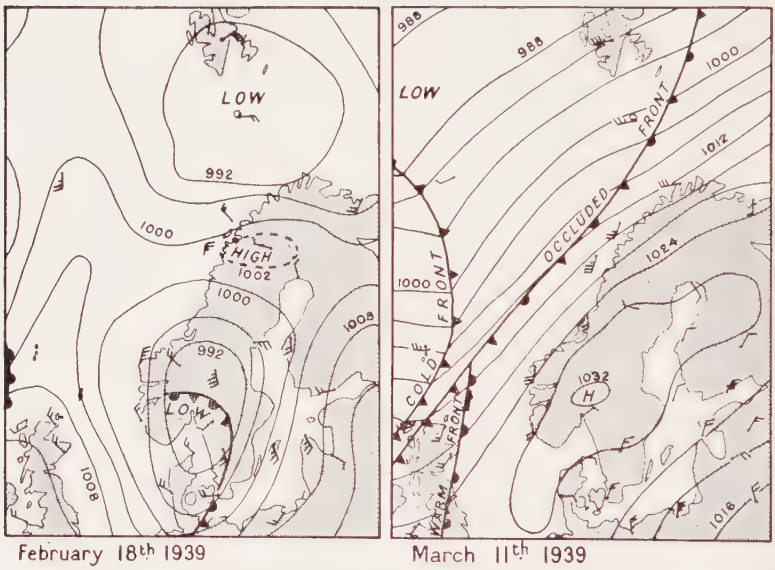


FIG. 18.—WEATHER TYPES.

The weather conditions are controlled by the balance of low and high pressure areas in relation to the polar front. Simplified examples are given for two days with the wind directions indicated by arrows. The number of barbs is proportional to the strength of the wind.

Based on Daily Weather Reports published by Air Ministry.

spring approaches in April the differences between the north and the south of the Scandinavian peninsula disappear, for the interior warms up, despite the snow cover, owing to the little cloud cover. In summer the northern territory of the peninsula is almost as warm as

the Stockholm archipelago but winter conditions are distinguishable by October when the north becomes colder again. This means that there is a great range of temperature in Norrland if there is no maritime influence penetrating. Local conditions may vary considerably with cold pockets created owing to the relief, for example at Stensele. Examples of the sequence of weather experienced are given in Figure 18 which shows representative cyclonic and anticyclonic development over Sweden.

Winter has been defined in Scandinavia as the period when the mean daily temperature is below freezing point and the summer as when the mean temperature exceeds 50° F. (10° C.): spring and autumn are the intervening transition periods and are shorter in the more continental areas of Sweden than in the maritime zone of Norway or in Gotland. In Lapland the summer, by this definition, does not commence until mid-June and autumn commences in the second half of August. Further south spring is earlier, for not so much of the insolation is used in melting snow and the air warms more quickly than it does over a reflecting surface of snow. The length of the summer, defined as above, varies considerably even in the 9° of latitude of Finland: in Lapland it is about 50 days and in the south about 110 days. Incidentally while the difference between mean temperatures may not be great the sum of the excess of temperatures above 41° F. (5 C.) —usually referred to as accumulated temperature —is very different between north and south: in north Lapland about 810° F. (450 C.) and on the south coast of Finland nearly three times as great.[1]

CHANGES OF CLIMATE

There have been many attempts to seek a rhythm of climatic change and Scandinavian workers have been in the forefront of research. One early study was that of Gerard de Geer on varves, and his geochronology was supplemented after 1921 by pollen-analysis of peat bogs. Such analyses carry the story down to Romano-British times, at which period peat growth virtually ceased in northern Europe and investigation since then has been based on historical records or by correlating the width of tree-rings which responded rapidly to differences of summer temperatures in the marginal growth area of northern Scandinavia. In Chapter 5 the changes are summarised in relation to the occupancy of Scandinavia

[1] Some Scandinavian writers have adopted 5 C. as the base for accumulated temperatures as compared with 6 C. (42 or 43 F.) adopted by French or British workers. Comparison with British conditions may be made from the paper by S. Gregory, "Accumulated temperature maps of the British Isles", *Trans. Inst. Brit. Geog.*, 1954, pp. 59–73.

by man and to the variations in the land and sea areas, but it must be remembered that the climatic control of human migrations is by no means proved. In historic times the advance of the Norwegian and the Icelandic glaciers during the years 1740–2, known in Norway as "the green years" because crops did not ripen, was accompanied by a deterioration of crop yields and farms were destroyed, which is strong presumptive evidence that earlier migrations could have resulted from climatic changes.

During the Ice Age there must have been anticyclonic conditions over the ice-cap and from this winds would blow outwards; strongly where the ice-edge was steep or weakly where it sloped gently. The

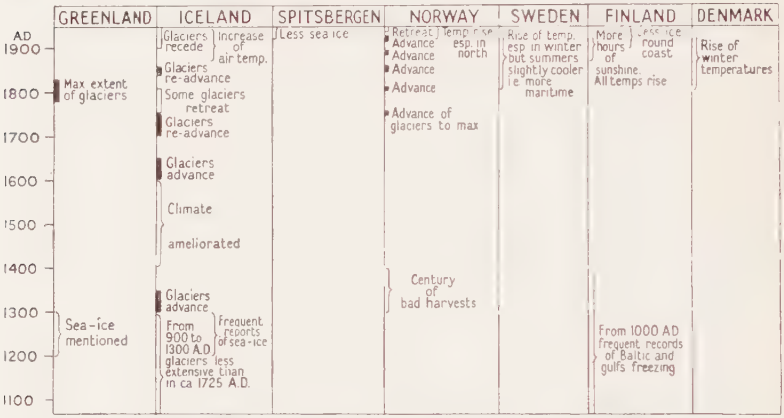


FIG. 19.—CHANGING CLIMATE SINCE 1100 A.D.

Historical records, which start just after the period of Viking expansion, show that the climate has changed considerably in the succeeding centuries. The evidence is qualitative rather than quantitative.

Based on G. Manley, "The study of climatic change", *Q.J. Met. Soc.*, lxx, G. S. Callendar, "Variations of winter temperature during eight centuries", *ibid.*, etc.

intensity of these winds declined as the ice-cap shrank, and as Ancylus Lake shrank so the summers became hot and southern deciduous trees, including maple, appeared in southern Sweden and the higher temperatures meant that ablation proceeded more rapidly and the ice-cap dwindled to two portions with the break at Ragunda.

The climate of the summers gave a rich flora but they tended to be drier than now for only with the collapse of the high-pressure system over the dwindling ice-sheet could the Atlantic depressions sweep over western Scandinavia. Until this occurred the islands of Norway were forest clad and the early Neolithic people had a very different habitat from that of the present day. As the fresh-water Ancylus Lake became replaced by the saline Littorina Sea the climate became

more maritime, and hot summers and cold winters were replaced by cool summers and mild winters, with a greatly increased rainfall. Peat bogs spread once again, only to be displaced with the disappearance of the Littorina Sea. Contemporary with warmer conditions in the Baltic area molluscs and seeds representing life which cannot now survive in Spitsbergen are found in the raised beaches and bogs of that archipelago so there was a widespread intensification of the gulf of winter warmth. Similar evidence of a warmer period is found in Iceland and Greenland.

By 1800 B.C. conditions had become drier for the depressions passed to the north of Norway; this seems to have produced a more favourable habitat for man in the north although it caused distress by drought further south. From 1800 B.C. to 500 A.D. peat bogs choked the forests and there was a cold deterioration of the Scandinavian climate as the Bronze Age passed to the Early Iron Age about 650–400 B.C. It was a period of great moisture and peat bogs spread further than ever before. The early part of the Middle Ages was marked by warm, dry climate which accompanied the Viking period, while the wet and cold of the later mediæval period was marked by a minor Norse migration.

Otto Pettersson has put forward the theory that periods of strong tides give stormy climates, bring sea ice equatorwards and that the periods of maxima have happened at 3500, 2100 and 350 B.C. and 1434 A.D.: the mediæval period was one of bad ice conditions round Iceland while that of 350 B.C. coincided with the peat-bog phase. The tidal minimum periods 2800 and 1200 B.C. and 530 A.D. were those of better climate and the last two periods coincide with periods of Scandinavian prosperity. The cause suggested by Pettersson may not be the only one but the coincidence between the tidal periods and climatic changes seems to be more than accidental.

Since 1921 the general warming of the Arctic Sea has been affected by a greater penetration of salt, Atlantic water and the results are dramatic with the length of the shipping season at Spitsbergen increased from an average of 95 days in the years 1909–12 to 175 days in 1931–8. The reduction of sea-ice formation would be partly caused by the greater amount of salt water and by the consequent diminution in the surface layer of easily frozen fresh water. Since 1917 the number of sunshine hours in the south of Finland has increased and there has been an extension of crop-growing northwards so it would appear as if the warming of the northern regions is due to an intrusion of warm air masses. At København the average temperature decreased in the second half of the nineteenth century, but since then has increased again and is now above the 1801 level: the winters show most difference and are not now so severe.

The retreat of the glaciers with a progressive rise of summer temperature has been rapid since 1930 and as a result arrows dating from the fifth century A.D. have been exposed on the Opdal Mountains in Norway and it is believed that these wooden weapons had been covered by snow and ice since they were dropped. Districts in Iceland which were cultivated six centuries ago and then covered by permanent snow are now being exposed again. In historic and recent times the recession of the ice, which has occurred virtually everywhere in the Scandinavian World, although not at the same rate, has

Summary of theories to explain climatic changes

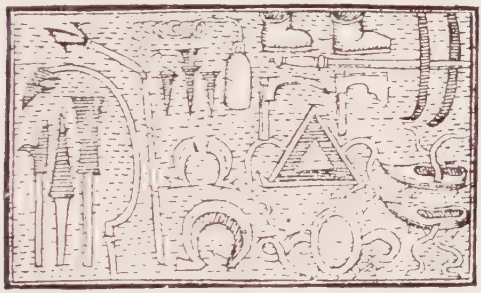
Author(s) and approximate date of theory	*Theory*	*Notes*
J. Croll (1875)	"Astronomical"	Believed changes due to eccentricity of the earth's orbit and of the ecliptic.
R. Spitaler (1921)	"Modified Astronomical"	Believed periods of eccentricity resulted in cooling of oceans which resulted in a glacial period.
Tyndall, Arrhenius and T. C. Chamberlin (1899)	"Carbon dioxide"	Believed reduction of CO_2 content of air allowed greater loss of heat from earth by radiation but water vapour acts in same way.
W. J. Humphreys and F. Frech (1920)	"Volcanic Dust"	Humphreys believed extra volcanic dust reduced temperature by "blanketing" and Frech believed it raised temperature.
H. Simroth (1908)	"Pendulum"	Believed geographical poles oscillated and this caused changes of oceans and of climates.
P. Kreichgauer (1902) and A. Wegener (1920)	"Continental Drift"	Believed continents moved under centrifugal force and that land-sea relation at some periods favourable to glaciation
C. E. P. Brooks (1917)	"Geographical"	Believed changes in land and sea relation and of altitude resulted in periods of "continentality" and so of glaciation.

been accompanied by a rise of winter temperatures, an increase of the ablation season and by an increased frequency of south-westerly winds. Ångström argued that when there was an increased "agitation factor", or vigour of circulation, between the sub-tropical latitudes and the northern latitudes it would be shown by a rise of temperature in the north and by a decrease in the more southern latitudes. Eriksson has analysed the relationships between barometric pressure, winds and drift ice in the North Atlantic and has shown that southerly winds have increased, with a moving northwards of the centre of the North Atlantic low and this has brought

greater warmth to the north. It is clear that there is some correlation, as yet not defined accurately, between the cold winters of Greenland and the warm winters of northern Europe.

Climate ultimately depends upon the solar radiation received and it is considered that a decrease of ten per cent in the radiation received would lower the mean annual temperature by about 12°F. (7°C.). It is believed that there cannot have been fluctuations of the radiation emitted by the sun on this scale and therefore it is necessary to consider differences at the terrestial, or receiving, end where the angle of insolation is important and various theories have been propounded to account for these changes.

To all these theories there are objections, and the causes of the Pleistocene Ice Age, which is of great interest to Scandinavian geography, are still undetermined.



CHAPTER 4

THE SURROUNDING SEAS

Scandinavia is so greatly influenced by the sea that it is necessary to consider the nature of the adjacent waters and to indicate some of the effects of the presence of the two main water masses—the Norwegian Sea and the East Sea—upon the geography and history of the Scandinavian World. The Norwegian Sea, the North Sea, the East Sea, the Barents Sea and the North Polar Sea are sometimes known, because of the way they are nearly surrounded by land, as the Arctic Mediterranean Sea. Since the Norwegian Sea and the East Sea are so different in character it is convenient to consider them separately. The marine factor in Scandinavia is so profound that it has affected the whole outlook of the Norwegian people and, through their contacts with western Europe, the history of the world.

THE NORWEGIAN SEA

Between Norway and Greenland and extending north of the ridges joining the North Sea platform by way of the Shetland Islands, the Færoes and Iceland to Greenland is the sea area which was first described scientifically, under the name the North Ocean, by Professor H. Mohn.[1] Various scientific surveys followed and resulted in the publication of the classical study by Helland-Hansen and F. Nansen, "The Norwegian Sea, its physical oceanography".[2]

The area of the Norwegian Sea is large, yet as a result of the presence of islands such as Jan Mayen, there is only a small tract more than 400 miles (640 km.) from land—a feature which helped the early sailors to cross the rather inhospitable sea. Large as this basin is, about a million square miles (2·58 million sq. km.), it is not self-contained, for water passes into the sea from the Arctic basin, with a sill depth of 820 fm. (1,500 m.), and from the Atlantic Ocean across a sill depth of 273 fm. (500 m.). Circulation of the water is thus affected by the conditions prevailing in these areas as well as in the connected shallow water areas of the North Sea, Baltic Sea and Barents Sea. Figure 20 shows the depths of the Norwegian

[1] H. Mohn, "The North Ocean, its depths, temperature and circulation," *The Norwegian North Atlantic Expedition* (*Vöringen*), 1876–8. Christiania, 1887.

[2] *Report on Norwegian Fishery and Marine Investigations*, II, 1909, No. 2, Christiania, 1909.

Sea; on it can be distinguished the main southern boundary ridges with subsidiary ridges dividing the area into the Greenland Deep and the Norway Deep with depths of over 1,914 fm. (3,500 m.). Of the various ridges one of great significance is the Wyville-Thomson over the saddle of which passes most of the inflowing Atlantic water, by

FIG. 20.—SUBMARINE CONTOURS IN THE NORWEGIAN SEA.

This relief map emphasises the basin form of the sea with the presence of ridges which divide it into smaller units. Current hydrographical survey is adding to knowledge of the form of the basin and although this map includes, by permission, material from the Louise A. Boyd Expeditions it must be regarded as tentative.

Based on B. Helland-Hansen and F. Nansen, *The Norwegian Sea*, Kristiania, 1909, Louise A. Boyd, *Coast of Northeast Greenland*, New York, 1948, Plate I, etc.

the Færoes–Shetland Channel. Between Iceland and Greenland is another ridge and across the saddle of this passes most of the water which flows from the Norwegian Sea into the Atlantic. There are irregularities within the basin, such as the volcanic cone of Jan Mayen Island and Louise A. Boyd Bank, which affect the flow of the circulating water. An interesting feature of the land and sea relation in the

FIG. 21.—SECTION FROM GREENLAND TO NORWAY

The oceanic depths of the Norwegian Sea are revealed in this diagram as also is the platform from which Jan Mayen rises. Based, by permission, on Louise A. Boyd, *op. cit.*, Plate I.

Norwegian Sea basin is to be found off the Lofoten Islands, where the continental edge is only a few miles from the shore (see Fig. 22); this has resulted in a focusing of fish migration. A further noteworthy feature is the trough which extends round the south of Norway; this may have been cut by a glacier when the sea level was lower.

In the top 273 fm. (500 m.) of the Norwegian Sea the waters are varied in character, for the water masses derived from the Atlantic, the Arctic and the coastal waters of northern Europe retain their characteristics for a long period. In the deeps the water is homogeneous and distinctive in character with its low temperature of 30·2°F. (−1°C.) and salinity of 34·92 per mille whereas the surface layers, resting on the denser water, have great variations of temperature through the year. The deep waters of the Norwegian Sea have a greater density than equally deep water in the Atlantic Ocean.

Atlantic water enters the Norwegian Sea as the Irminger Current (by Denmark Strait) and as the Gulf Drift or Norwegian Atlantic Current (either side of the Færoes) and by these relatively shallow entrances the saline water of over 35·0 per mille is usually kept to the top zones. The flow lines cannot be explained in simple terms for there are vortex movements: Atlantic water, for example, flows south along the eastern side of the Færoes. The Atlantic Current is deflected to the right by the earth's rotation and, known as the Norwegian Current, it covers the edge of the continental shelf of Norway although there is a surface layer of fresher coastal water. This North Atlantic Drift across the Norwegian continental edge acts as a moving rampart against the cold arctic water, which is thus prevented from penetrating into the fjords and Skagerrak.

The water entering through the Færoes–Shetland Channel, although Helland-Hansen and Nansen estimated it at 4–5 million

cubic metres per second (a cubic metre is over 35 cu. ft.), does not fully occupy the available channels and there is an outflow particularly across the Iceland–Greenland ridge, and also between Iceland and the Færoes. There is also some loss into the North Polar Basin between Spitsbergen and Greenland and into the Barents Sea. Cold polar water enters the Norwegian Sea by the Bear Island Arctic Current, the Spitsbergen Polar Current and the East Greenland Current and this water is distinguishable by its very low temperature and comparatively low salinity which facilitates surface freezing.

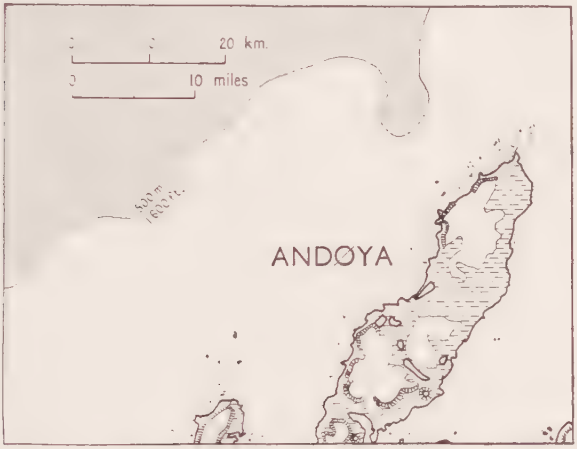


FIG. 22.—CONTINENTAL EDGE NEAR THE LOFOTENS.

Off Andøya the continental edge approaches very close to the land which here has a well developed strandflat (indicated by broken ruling). The narrowness of this sector of the continental shelf is unique in Europe.

Based on German wartime charts.

These streams of water tend to glide over warmer, but more saline, masses. The balance of water in and out of the Arctic Mediterranean Sea has been given in million cubic metres per second as:

Inflow north-west of Scotland	3·0		
Inflow through Bering Strait	0·3		
Run-off from rivers	0·16		
Excess precipitation over evaporation	0·09		
	3·55	Outflow through the Denmark Strait	3·55

(H. U. Sverdrup, M. W. Johnson and R. H. Fleming, *The Oceans*, New York, 1942, p. 655: these estimates do not agree exactly with certain estimates by Helland-Hansen and Nansen.)

The Denmark Strait Polar Current, which is the main outflow from the Norwegian Sea, has a narrow belt of polar water over the edge

of the Greenland continental shelf and slope and as this water moves slowly it accounts for the accumulation of ice in this area. The ice which occurs is of three varieties: polar ice, found in thick floes; Arctic or day ice which is in thinner floes and, containing much brine, melts more easily from insolation; and icebergs which are

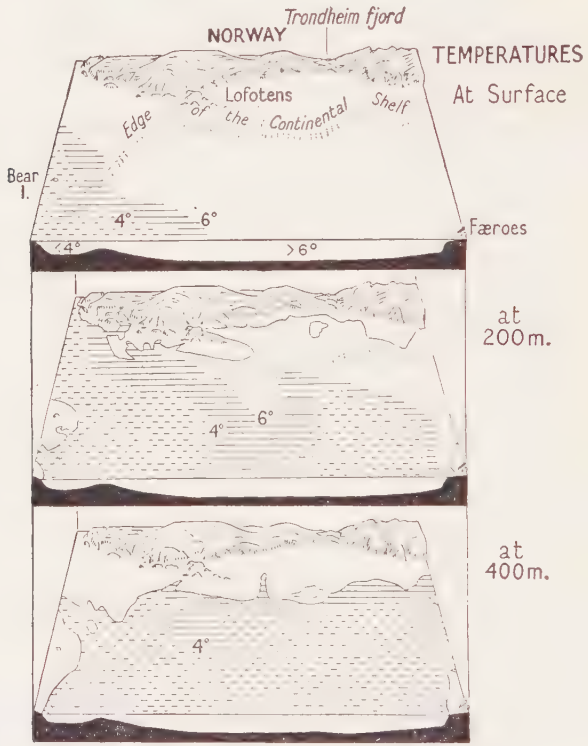


FIG. 23.—TEMPERATURES IN THE NORWEGIAN SEA.

These block diagrams are taken from the west and show how at the surface there is a wide expanse of warm Atlantic water, whereas at a depth of 200 m. (656 ft.) there is a wider expanse of water cooler than 6°C. (43°F.) and at 400 m. water colder than 4°C. (39°F.) dominate the scene.

Based, with modifications, on B. Helland-Hansen and F. Nansen, *op. cit.*, Plate XIII.

calved from glaciers. The melting of these ice masses in summer prevents the solar heat from reaching far below the surface, but the presence of the ice cover reduces the loss of heat by radiation in the winter.

The coastal waters of Norway have a salinity below 35·00 per mille, but the salinity varies considerably with the year and the season

according to rainfall and snow melt on the land. From the Skagerrak the Baltic Current flows along the Norwegian coast with a very irregular rate of flow until it meets the southward flowing coastal current.

The temperature of the Atlantic water entering the Norwegian Sea affects the winter temperatures experienced at Norwegian land stations, but, owing to the slow speed of the drift of Atlantic water,

FIG. 24.—GENERALISED FLOW OF WATER IN THE NORWEGIAN SEA.

While there is a flow of warm water northwards along the eastern margin of the basin and of cold water southwards along the western margin the water masses slacken speed in their course and have numerous eddies.

the effect of a large influx of cold water will be felt more than a year later in northern Norway. As the inflowing Atlantic water is at 46·4 F. (8 C.) and the outflowing water through Denmark Strait is at 30·2 F. (−1 C.) the quantity of heat released to colder waters or to the air is very considerable. As at least half this heat is given off along the coast of Norway it readily accounts for the great positive anomaly of air temperatures in the Lofoten area.

On the periphery of the Arctic Sea there is a zone, between

Greenland and Spitsbergen, where during the winter ice forms and continues to increase in thickness until April or May. During the summer this ice fringe is partly melted and partly broken into blocks and at this stage the ice is most freely affected by movements of the sea and of the air. The fragments of the Arctic Pack tend to drift out of the Arctic Basin and the principal outlet is that between the Spitsbergen archipelago and Greenland and so most interference to navigation from icebergs occurs in the North Atlantic Since the dramatic loss of the *Titanic* in 1912 a watch is kept on the southward movement, across the Atlantic travel-lanes, of the ice fragments. An amelioration of the northern climate has resulted in less sea-ice being formed and also, with the retreat of the snouts of various glaciers, has meant that there are fewer large icebergs. It was fortunate that the need to run convoys to Murmansk during the Second World War coincided with a period of less ice formation so that there was a relatively wide strip of clear water north of Norway and the vessels were not forced in towards the Norwegian coast where they would have been more liable to enemy attack.

Temperature conditions modulate the cycle of life in the seas and this is of prime importance in the Norwegian Sea because of the significance of the fisheries. In 1929 an abnormal volume of very warm and saline Atlantic water entered the Norwegian Sea and two years later the waters of Spitsbergen were warmer and cod were once again caught off Spitsbergen in appreciable quantity. Relationships have been established between the physical conditions of the water and the size of the liver and the quantity of roe of cod in the following year. Years of unusually warm water are followed by poor development of the cod and haddock and, in the case of the Lofoten cod fisheries followed seven years later by poor catches. In the case of the capelin fishery of Finmark the fluctuation occurs about five years later as the cod are here caught when younger.

The condition of the coastal waters can also be of significance. In a dry year the water becomes more saline than average and the sprat catch of the following year and of the small herring two years later is reduced. These correlations are given as examples of the more simple relationships which have been deduced and it is apparent that all the interactions cannot be studied until there is more detailed knowledge of the physical and chemical conditions of the waters.

EAST SEA (BALTIC AND ASSOCIATED GULFS)

This is the largest brackish water basin in the world, having an area of 170,000 sq. miles (422,000 sq. km.), of which under half is in the Baltic proper. The floor of the East Sea is much more broken

and ridged than a single bathymetric chart would suggest. Between the Kattegat and the Baltic proper, which commences at the southern end of the Sound, is a transitional threshold which is sometimes known as the Belt Sea where, with depths of about 11 fm. (20 m.), the salinity is intermediate between that of the open sea and the 2 per mille of the northern end of the Gulf of Bothnia. Within the East Sea is a small series of basins, with a maximum depth of about 137 fm. (250 m.), separated by shallow shelves, and in these areas of

FIG. 25.—DEPTHS IN THE EAST SEA.

Submarine contours are at 50 m. and 100 m. (164 and 328 ft.) with depths below 100 m. ruled. The East Sea is seen to consist of a series of basins with a very shallow outlet and the water in the depths tends to remain stagnant.

deeper water the lower layers are of higher salinity and of higher carbon dioxide and hydrogen sulphide content but are deficient in oxygen and phosphates so that marine life is greatly handicapped. The southern part of the Gulf of Bothnia is almost a separate sea, with depths as great as occur in the Baltic, but it is only joined to the Bay of Bothnia by the broad and shallow shelf of Qvark.

More than three times as much water enters the East Sea by rain and rivers than is evaporated and so there is a considerable discharge at the mouth. Despite this great outflow a counter current of saline

water enters and increases the salinity of the Baltic. In the entrance to the East Sea is the complicated hydrographical area of the Skagerrak and Kattegat where North Sea water, with a salinity of 30–34 per mille, meets Baltic outflow water with a salinity of under 15 per mille; with this it slowly mingles as it is turned along the Norwegian coast. The summer warmth and the freshness of this Baltic outflow cause it to override the salter masses. The North Sea tides cannot force their way into the East Sea and so the tidal rise is weak and with a frequency of a day instead of half a day. The surface of the East Sea is "warped" and is piled higher in the north than in the south, possibly as a result of the prevailing winds in north-western Europe being from the south-west.

FIG. 26.—FREEZE-UP IN THE GULFS OF BOTHNIA AND FINLAND.

The ruled areas are those liable to most solid freezing and the flecked to intermittent closing.

Based, by permission, on *Atlas of Finland*, Helsinki, 1925, etc.

Ice conditions in the East Sea are severe, for the innermost part of the Gulf of Bothnia is frozen over for more than half the year. Even in summer the water does not get very warm on the surface while the water at 20 fm. (35 m.) is at arctic temperatures. Owing to the narrow channels of the Belt these waters cannot be directly warmed by the Atlantic Drift. As a result of the perennial coldness it is possible for species of marine life which are glacial relics to survive in the East Sea. The ice in the East Sea only begins to form when the upper layers of water have lost their summer heat and it appears round the coasts as a zone of fast ice (Figure 26); beyond this, in cold spells, is developed a skin of ice which can be broken by the wind and packed along the edge of the fast ice or drawn into the open sea. The fast ice may, in severe winters, exceed a metre in thickness while the drifting ice may mass into a bank 50 ft. (15 m.) high. The ice usually clears fairly quickly, but in cold summers, such as that of 1867, which are the famine years, drift ice occurs in the Qvark until the middle of July. In severe winters, which are about one in five, ice can interfere with navigation in the Sound and can close all Danish ports except Esbjerg.

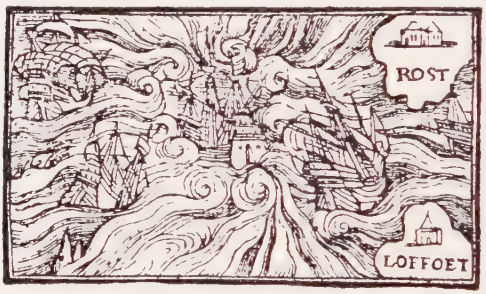
MARINE FAUNA

The waters round the shores of the Scandinavian World include part of two zoo-geographical regions—the boreal and the polar—with the boundary between the two indefinite because over a broad zone the temperature range is sufficient, in the surface waters, to allow arctic animals to propagate in the winter and more southerly types in the summer. Among the fish of commercial value are cod, coalfish, haddock, ling and herring. Cod and coalfish when spawning, and at the adult stage, are pelagic, while the herring lays its sticky eggs on the sea floor or on seaweed and the locality is chosen by the fish's sensitivity to temperature and salinity conditions. With the improvement of climate which has occurred the boreal cod are now spawning further north where the water has a temperature of 39·2–42·8 F. (4–6 C.) and is over 34 per mille salinity; in the Baltic the cod spawns in fresher water than this. The Norwegian coast, the north-west coast of the Færoes and the south coast of Iceland and the west coast of central Greenland are at present the main spawning grounds for cod. Haddock need warmer water and a salinity of up to 35·2 per mille for spawning, and so the banks are found in the northern part of the North Sea, while coalfish require still warmer water with a salinity of at least 35·2 per mille.

In 1873 G. O. Sars postulated that the Norwegian herring shoals came in from the open ocean and since then there have been studies of the Norwegian Sea in order to establish the migration routes and to aid the forecasting of catches. A new Norwegian research vessel, *G. O. Sars*, was equipped in 1950 and the herring shoals were located when they were beyond catching depth by means of its ASDIC apparatus. Early in the winter of 1950–1 herring were found in the cold water north of the Færoes and these were traced in the following new year along a wedge of cold water towards the Norwegian coast, but the shoals kept below the surface layer of cold polar water. Whilst this is a big advance of knowledge, suggesting that a study of cold and warm fronts in the ocean may be as useful as in the air, the problem still remains as to where the fat herring live before coming in to spawn.

In the East Sea the semi-Arctic conditions provide an opportunity for arctic life, such as a species of seal, to survive while the reduction of salinity has prevented the immigration of certain species which could survive the temperature conditions. Some marine forms of life are able to adapt their metabolism to brackish conditions and some fresh-water species have been able to tolerate brackish water. Of the marine forms which live in the Baltic the most valuable to man is the small Baltic herring (*Clupea harengus membras*).

Scandinavian waters have played a considerable part in the settlement of the region whether in providing routeways or in providing a means of livelihood. To the traveller they often appear storm-tossed wastes of grey water but they are far from uniform in characteristics, and as more becomes known about their composition so the appreciation of their effects on the historical and economic geography becomes finer. Already it is possible to see some of the interrelations between the conditions in the seas and the climate and the fisheries, and with the keen Scandinavian interest in fishing active research is being prosecuted.



CHAPTER 5

EARLY MAN IN SCANDINAVIA

The pattern of man's early settlement of Scandinavia can occasionally be seen through the mists of time to gleam brightly, but then the light fades and the pattern becomes confused and dark even though it was woven later. Within this northern habitat the archæological evidence is far from complete and much must remain surmise, yet enough is known to glimpse the ebb and flow of peoples, one culture impinging upon another, and the outline of the story will in this chapter be carried on as far as the days of the great Viking movements.

If any life existed in Scandinavia before the Ice Age all trace of it was obliterated by the great Quaternary glaciation.[1] At the last advance of the Ice-sheet western Jylland and stretches of the Norwegian coast were not ice covered so it is possible that there were then settlements similar to existing Eskimo settlements on the coast of Greenland. Only after vegetation, and the accompanying fauna, had established itself on the retreat of the ice could man settle, or re-settle, in Scandinavia. Flint and reinder-horn implements found near Hamburg can be dated geologically and reveal that when the ice edge extended as far south as Holstein man approached the borders of the ice. The early post-glacial period is the first in which definite human traces can be distinguished in Scandinavia; poplar forests were appearing in the south but reindeer, which ranged to the shores of the Mediterranean in late-glacial times, still remained, and worked reindeer-horn implements, combined with simple flint forms, are found. These relics of what is termed the Lyngby (Nørre-Lyngby, Jylland) culture are not accompanied by any traces of dwellings and they were probably dropped by hunting tribes.

Slightly more elaborate flint implements have been found at Varberg (North Halland in Sweden) in clays of the Gothi-glacial period when man lived under the edge of the ice-sheet, while at Halden (Østfold in Norway) are dwelling-stations in an area of subarctic climate prior to the *Tapes* subsidence. Along the west coast of Norway flint implements (Fosna type), dropped prior to the *Ancylus* period, are found on the floors of sheltered valleys from Bergen to Trondheim, and Komsa culture implements are found along the

[1] Flints believed to be genuine eoliths have been found in glacial deposits in Holstein, while in Jylland one undoubted flint artefact has been found in interglacial material.

Arctic shores of Alta and Porsanger. These Fosna and Komsa flint localities may be due to the movement of palæolithic people along the Arctic shore either from Siberia or from the North European plain. Finland was first occupied by man about 7000 B.C. and, owing to progressive uplifting of the land, the older Stone Age relics are found higher on the older beaches. It would be expected that traces of the Komsa culture would be found in the country, but none has, as yet, been located.

FIG. 27.—STONE AGE SITES ALONGSIDE THE LITTORINA SEA.

Stone Age settlements are indicated by dots and it is seen how in this district they were normally located beside the embayment of the sea which is shown by stippling. Present-day lakes are indicated in black and modern farms by rectangles.

Based on M. Sauramo, "Quarternary Geology of Finland", *Bull. de la Comm. Géol. de Finlande*, Nr. 86, 1929, p. 102.

When fir forests covered southern Scandinavia man lived on firm land beside lakes and the remains show that he hunted with bow and arrow aurochs, elk, hart and other animals, snared heron, geese and other birds, ate pike and gathered the seeds of the hazel and water-plants (*Nuphar luteum* and *Trapa natans*). This hunting phase is accompanied by the use of horn and bone implements so it is known as the Bone Age of Maglemose (Sjælland), where the relics of it are considerable. Traces of this culture, which used flint to work the other material, are found in Sweden as far north as Jämtland and in southern Norway; the associated Kunda culture of the East Baltic States extends into southern Finland.

As the land subsided once more and the climate changed from Boreal to Atlantic the "bone" culture gives way to the "kitchen-midden", and finds near København and Stavanger reveal that there was an intermingling of old and new elements. This younger culture (Ertebölle) is that recognised in the large kitchen-middens of Denmark which were formed before the lowest point of the subsidence and continued after the land had commenced to rise again. The dwellings are situated along the shores of the contemporary fjords and are often sheltered from winds by a hillslope. The kitchen-middens are formed of huge masses of the shells of oysters, cockles, mussels and periwinkles and, as the people lived on top of them, a wide range of material, such as the bones of sea-birds, was enclosed

and preserved. The contents reveal that this was a hunting and fishing people with the dog their only domestic animal. Fishing, in part, was done by means of basket traps woven out of twigs. The wealth of the enlarged Baltic attracted people to the sea while elk and aurochs were replaced by the red deer as the oak displaced the fir in the forests. Bone implements were replaced by more elaborately worked implements of flint and igneous rock and pottery was produced. While these people were living beside the shores of the salt water others were living inland and, in place of shellfish, hazel nuts supplemented hunting. In Denmark it appears as if this newer Ertebølle culture was due to incoming bands of people who mingled with the older groups. Further north, where flint deposits were absent, there was a greater use of igneous material and a longer continuation of the use of bone and horn; life remained more primitive. This culture is known as the Lihult (Bohuslän) or Nøstvet (Oslo) and is contemporary with the Ertebølle of Denmark. Finland at this period had a culture known as Suomusjärvi which extended from that of Esthonia and had no contact with the rest of Scandinavia. This culture is distinguished by the implements shaped by grinding and the absence of flint and represents a continuation of the Kunda culture.

Following these hunting phases changing conditions in southern Scandinavia encouraged a turnover to agriculture. Denmark and Sweden had a mild and dry climate which was warmer than the present and in Norway the tree level was about 650 ft. (200 m.) higher than the present tree-line. In the south of Scandinavia flint and amber gave further wealth to the region, and thus it became a leading area while the north was still primitive and only slowly adopted newer cultural features. With the Later Stone Age the grinding of flint was introduced which allowed improved weapons and implements. Associated with the changing conditions are the megalithic graves with full burial rites which have left many relics and skeletons for study. The human remains show that they were a mixed people—both long and short heads—who suffered from arthritis and rickets owing to the living conditions and were prone to accidents. The skill of these people was not negligible for skulls found show dexterous surgicaltre panning for head injuries. Flint was finely worked and an excellent pottery was made which bears witness to contact with western Europe. This megalithic culture was centred on Sjælland and extended westwards over Jylland, eastwards over Sweden south of Lake Väner, to Öland and Gotland and northwards to Oslofjord. While these megalithic people occupied the farming land the kitchen-midden people were still engaged in hunting and fishing in the same district.

Pushing from the south came an influx of "battle-axe" people who buried their dead in single graves; evidence shows that these people did not come from western Europe, as did the megalithic, but from central Europe. Danish archæologists have shown that these single-grave people, starting from Jylland, drove out the megalithic folk. In Sweden and Finland this culture can be recognised by special axes as well as by the graves of the people, but in Finland this was an impingement on Suomusjärvi culture for the megalithic people never penetrated so far north. In Norway the weapons are found, but not the single graves, and this may be evidence of cultural borrowing. While the culture of the south was transformed into neolithic civilisation that of the north remained in a more primitive form known as the Arctic Stone Age with the people still hunters and fishers. Peasant culture in Norway, from the third chiliad B.C. has been linked with the coast and in these coastlands there has been from Neolithic times until today a fusion of agriculture, grazing and fishing. Lacking local flint these folk worked up igneous rock and slate for their tools and weapons and there is evidence that fine-grained stone (granulite) was quarried near Oslo, on the island of Bømlo (south western Norway) and at Olonetz (on the western shore of Onega) and from these three centres was carried to the north for tools and weapons. Further evidence of the distances material was carried comes from the precious amber; Jylland amber travelled to Jæren, near Stavanger, while Prussian amber went to Finland, Sweden and north-west Norway. Finds of flint implements beside the estuary of the river Byske in Västerbotten suggest that this was a trading centre of Skåne flint for northern Sweden, and in view of the sparsity of flint in the north, the trade must have lasted a long time to sustain the Arctic culture. Therefore while these people remained primarily as hunters and fishers they received some influences, including the use of six-row barley, from the south and their culture is termed sub-megalithic. In prehistoric Europe tilling of the land did not spread north of the limit of deciduous forest, and until coniferous forest was replaced by deciduous the hunting-fishing economy was not displaced. About 2000 B.C. the boat-axe culture reached Finland and these people, whose culture had originated further south in an agricultural region, sought out the clay areas; but the Stone Age culture supervened and a mixed economy continued while there was a Bronze Age in the southern part of Scandinavia.

After a long period when the use of copper and bronze prevailed over most of Europe, but was rare in Scandinavia, there came a flourishing Bronze Age. At first the Bronze Age people of Scandinavia depended upon imported ware but later made their own castings. There is evidence from the ornamentation that the early

forms were derived from the Mediterranean *via* central Europe but later western forms arrived. From Bronze Age rock-carvings of ships in Bohuslän, possibly dating back to 1400 B.C., it is clear that there was an active maritime life in Scandinavia and one vessel is portrayed with fifty rowers showing that the craft were large. A bronze-casting workplace has been discovered in Denmark; this shows that the skill of the workers was considerable. The great

*Bronze Age Chronology**

	Phase	*From*	*To*
Late Bronze Age	6	middle 8th century B.C.	end 7th century B.C.
	5	middle 10th „	middle 8th „
	4	beginning 11th „	middle 10th „
Early Bronze Age	3	beginning 13th „	end 12th „
	2	middle 16th „	end 14th „
	1	beginning 18th „	middle 16th „

* This is the classification of Oscar Montellius. S. Muller has a different division and the chronology differs with the Early Bronze Age beginning in the middle of the second millenium B.C. and lasting about 800 years.

quantities of metal required came partly from the British Isles, but more was brought from south-east and central Europe and for it, and for gold, the amber of Jylland was exchanged: the route at first was that using the Elbe, but as the Prussian amber trade developed the route moved east. Amber, cherished for ornaments, has been found cast up on many shores but in Europe mainly on the west coast of Jylland and on the Baltic shore east of the Vistula; these sources of amber, which can be distinguished by their succinic acid content, have been recognised in amber ornaments found in Grecian graves of the fourteenth century B.C. The main centre of bronze working was in Denmark and Skane with a secondary province of production, which shows eastern European influences, from Finland to Mälar. North of 68° N. there is no trace of Bronze Age culture and here the Arctic Stone Age persisted during the rich Bronze culture of the south; in other words northern Scandinavia was part of a primitive circumpolar culture whereas the south was participating in, and being invigorated by a spread of the heritage of southern Europe. The Bronze Age is represented in Finland only to a slight extent: the finds are few and are mainly of imported items which reveal contact with both Sweden and central Russia.

These people of the Bronze Age were tillers of the soil, using the plough and not the hoe, growing barley, wheat, oats, millet and flax and keeping cattle, sheep, goats and horses; but they also continued in the deciduous forests to trap wild animals. Their graves were

great mounds of turf and sand built over a stone or oak cist. Fabric, preserved by the tannin of the oak cists, shows that they wore clothes of a coarse woven wool. During the Late Bronze Age cremation prevailed and relics become more scanty; the urns for the ashes were usually placed under small mounds.

Before the end of the Bronze Age iron was used in Scandinavia; as with the Bronze Age in-coming the older culture persisted in northern Scandinavia after the newer was well established further south. Unlike bronze, which had to be imported, iron was easily obtained as bog-ore and also was easily smelted in pits using wood

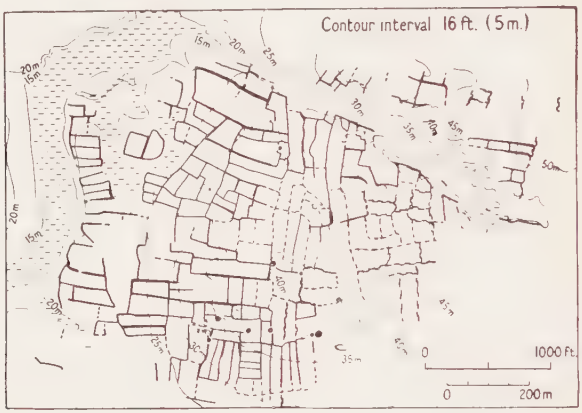


FIG. 28.—IRON AGE SETTLEMENT AT SKØRBÆK HEATH, HIMMERLAND.

The contours are at 16 ft. (5 m.) interval and the modern marshland is shown by broken horizontal ruling. Field boundaries of the Iron Age are shown by the heavier lines and settlements and graves by dots.

Based, by permission, on G. Hatt, "The ownership of cultivated land", *Det Kgl. Danske Videnskabernes Selskab, Historiske-filologiske Meddelelser*, 26e, København, 1939, p. 22.

fuel; furnace scoriæ have been found. Gudmund Hatt has examined geographically the Older Iron Age village in Ejdrup parish in Himmerland, Denmark. It was an age of poverty for the Celtic migrations across Europe disturbed the ancient links between Scandinavia and the Mediterranean. The most northerly Iron Age find lies south of 60° N. and this regression from the Bronze Age limit is due to the colder climate of the sub-Atlantic period; famine must have raged in the north during the sharp climatic deterioration. The Celtic Iron Age, as it is termed, is divided into three phases: the first 500-300 B.C. and the second and third divided about 100 B.C. Pytheas of Massalia explored northern Europe about 330 B.C. and he records that the northern peoples practised agriculture and that corn was thrashed in buildings because of the damp climate.

This undaunted explorer, the first to bring first-hand knowledge of the north to the Mediterranean scholars, established latitudes far to the north of the then known world, but unfortunately the only records of his writings are excerpts, torn from their context by later and disbelieving writers. However, it is clear that Pytheas had seen sea-sludge when he speaks of a sluggish and congealed sea which cannot be traversed either by boat or on foot,[1] and even if his travels were disbelieved the accounts made the Mediterranean people aware of the north from which they drew furs and amber. At this period the Teutons dwelt in Jylland, west of Limfjord, and the Cimbri to the east and their migrations southwards in the years 114-102 B.C., which led them to battle with the Romans, are the first historical record of Scandinavian peoples migrating.

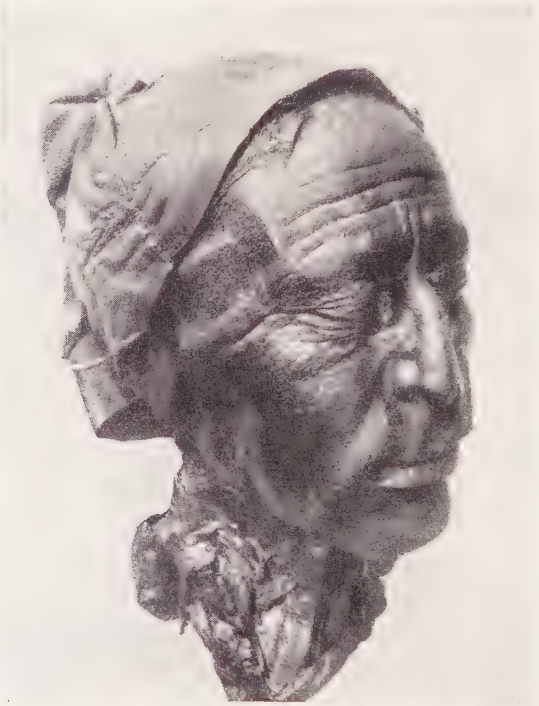
Iron furnaces and iron scoriæ which have been found at Fogstrup, near Silkeborg, and Bækmoien, near Fredrikshavn, have been dated by Gudmund Hatt to the Old Iron Age of the sub-Atlantic period. Alongside Ringkobing Fjord is an Iron Age dwelling, dating from the first and second centuries A.D., situated on a natural sandhill. During the Roman Iron Age this sandhill was surrounded by water and marshes but since then land uplift has caused the natural defences to disappear.

The Roman Iron Age followed in Scandinavia when Italian products were passed along the Elbe to Jylland and along the Vistula to the Baltic and Sweden, while trade went by sea from the mouth of the Rhine and crossed Holstein to Sweden. The foci of these arteries were the islands of Sjælland and Lolland and from here Italian goods and ideas, later supplemented or replaced by those from Gaul, radiated to the north. Towards the end of the second century A.D. the Goths pushed southwards from Götaland and Gotland and along the line of this advance there flowed back to the north, for over a century, southern culture including runic writing. The great piles of broken armour found in bogs of Fyn and Slesvig show that Germanic people must have migrated northwards towards the close of the period. The penetration of Roman Iron Age culture into Finland was delayed and was gradual when it did occur. While Roman type remains are found in Swedish Norrland they were contemporary with Finno-Ugrian incursions into the south and east of Finland, which country had its Iron Age starting at the beginning of the Christian era when the Finns migrated as fur hunters and farmers from Estonia.

The cultural flow from the south-east of Europe into Scandinavia came to an end after the middle of the fourth century A.D., when the Goths fled westward to avoid the Huns, and trade again used the

[1] Strabo, ii, 104.

Rhine and the Elbe. This unrest in the North European Plain probably resulted from the climatic deterioration which forced the barbarians, in their search for food, against the Roman-held territory. With the break-up of the Roman Empire, which resulted from the great tribal migrations, quantities of gold flowed northwards into Scandinavia. The influence of Rome declined and an indigenous



Photograph by courtesy of the Silkeborg Museum and Roy. Mus. of Antiquities, Copenhagen.]

FIG. 29.—HEAD OF THE TOLLUND MAN.

The head of this man, with the nose only slightly crushed, has been preserved in a peatbog for about 2,000 years and is a unique example from northern Europe of the people who once occupied the region.

Norse culture arose despite unrest in the north witnessed by the hill-fort construction of the period. It was during this period that the Finnish people lost their connections with the East Baltic States and established more contacts with Scandinavia—contacts which were strengthened by the Swedish Vikings entering Russia by the Gulf of Finland and by the Swedish settlements on the coasts of Finland.

Cassiodorus, chancellor of Theodoric the Great, in writing a history of the Goths described the Scandinavian people as tall and added: "These nations fight with the ferocity of wild beasts and are mightier than the Germans both in body and soul."[1] During this period the Baltic, and especially the island of Gotland, became a centre of trade between southern and northern Europe. At this period, when the Anglo-Saxons were conquering Britain, the Swedes of Uppland were conquering their southern neighbours of Götaland and Gotland, the Danes from Sjælland were establishing their kingdom and in southern Norway there was consolidation of a number of tribes under a king, although Swedish influence was strong around Trondheim and North Sea cultures prevailed in the west. Finland and the Baltic States were also strongly influenced from the fifth century by Swedish culture which flowed across the Gulf of Bothnia.

Consolidation of the Swedish Kingdom was a necessary prelude to expansion, and evidence for this may be obtained from the writings of Procopios the Greek, of Jordanes and from the Anglo-Saxon epic *Beowulf*. Jordanes, writing in about 550 A.D. refers to twenty-seven nations in southern Sweden and Norway but only to the *Svear* people in central Sweden, and he refers to their trade with Rome in fine furs. *Beowulf*, written about 700 A.D., refers to changes in the political entities as a result of the Svear people conquering the Västgöta kingdom between 550 and 575 A.D. The *Guta Saga* refers to over-population in Gotland and states that one-third of the population, chosen by lot, had to leave and they migrated across the Baltic to Dagö, off the Estonian coast, up the Dvina river and across Russia to Greece, where they settled. Grave-finds show a sudden decrease for the period after 475 A.D. and, as the burial customs remained constant, it shows there was here a sudden decline in the population while for this same period there is an increase in the Gotland types of relic found in the east Baltic area. About 550 A.D. the older culture relics cease and others, which are also in central Sweden, appear and it was about this period that Gotland was incorporated in the enlarging Swedish Kingdom. During the period of unification which followed in the seventh century land was reclaimed and roads were built. After the battle of Bravalla Moor, in Östergötland, which was fought about 745 A.D., the Svear obtained control of lands to the south and by about 800 A.D. the Swedish kingdom was an entity. When Alfred the Great translated into Anglo-Saxon the history by Osorius he added an account of a voyage

[1] From Epitome of this history by Jordanes the Goth, written mid-sixth century.

to the Baltic made about 850 A.D. by Wulfstan in which he refers to the lands of Blekinge, Möre, Öland and Gotland and says that they were all belonging to the Svear. This kingdom, unified under one king, was really a group of states which paid tribute to one man and had a joint military organisation but still preserved their own laws; and indeed for centuries Sweden did not have a common code of laws.

From just before the beginning of the ninth century the Scandinavians first made their major impression upon European history when the Viking pirated and invaded most of the coasts of the continent. It is certain that Norwegian colonisation of the northern islands of Scotland preceded the great outbursting. The vivid words of Gibbon give some idea of the drama of the impact of the Northern people upon the Holy Roman Empire. "The Normans [i.e. Northmen], who had so long been concealed by a veil of impenetrable darkness, suddenly burst forth in the spirit of naval and military enterprise. The vast, and, as it is said, the populous regions of Denmark, Sweden and Norway, were crowded with independent chieftains and desperate adventurers, who sighed in the laziness of peace and smiled in the agonies of death. Piracy was the exercise, the trade, the glory, and the virtue, of the Scandinavian youth. Impatient of a bleak climate and narrow limits, they started from the banquet, grasped their arms, sounded their horns, ascended their vessels, and explored every coast that promised either spoil or settlement."[1] These Viking raids started by minor ventures to the Baltic States and westward to Friesland and the British Isles. In 793 there was a sudden descent upon Lindisfarne in Northumberland and

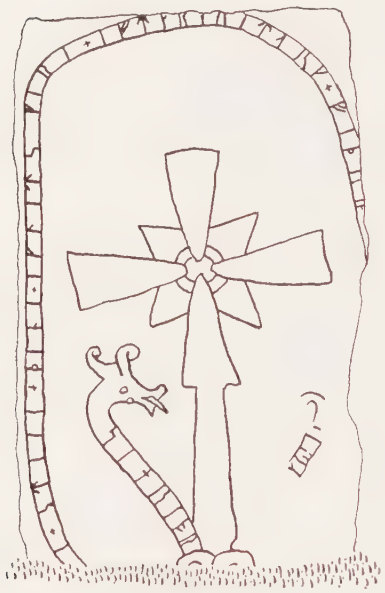


FIG. 30.—A RUNIC STONE.

This eleventh-century runic stone is set in the south wall of the church at Gamla Uppsala, Sweden. The inscription, partly lost, can be freely rendered as: "This stone to Sl Julþr, traveller to England after his father Vltarf".

[1] Gibbon, *Decline and Fall of the Roman Empire*, Chapter LX (Edition 1815, Vol. X, pp. 220–1).

almost every year thereafter raids are recorded, with horror, by the monks of western Europe whose possessions were ravaged. During the ninth century the raids became larger and more systematic; moreover, fortifications for winter quarters were established in the attacked districts, and formed bases for further conquest and colonisation. The tenth century, when Harald Fairhair ruled in Norway and Gorm the Old and his son Harald Bluetooth in Denmark, was a period of

FIG. 31.—VIKING ROUTES.

In these migrations the water routes were significant whether, coastwise, to the western Mediterranean or, by the Russian rivers, towards south-east Europe. Sites such as Hedeby or Grobin were focus points for trading activities and the island of Gotland acquired wealth.

quiescence. After a brief period of recrudescence of the attacks, when the Danes conquered England, the Viking period came to an end with Christianisation.

The oldest Swedish colonies in Russia were planted south and south-east of Lake Ladoga, and later the Vikings advanced southwards by the great rivers of Memel, Dvina and Dnieper to Kiev. Finds from the eighth century reveal two Swedish towns, at Grobin and Apvolé which were trading centres. The Vikings apparently

travelled as traders, as well as raiders, to tap the wealth of the Arab merchants who brought oriental goods to the margins of Europe; the Swedes, in return, carried south slaves, furs and honey. Many Arabian silver coins have been found in Sweden, particularly in Gotland. At the same time to control the traffic passing from south-eastern Europe to the north-west the Swedes obtained control of the nodal town of Hedeby, situated where there was the best crossing of the neck of the peninsula of Jylland, and so had strong points along a route between the Black and North Seas. From Kiev they attacked Constantinople and other Black Sea ports in 866, 907, 941 and 944.

In time the Swedish ruling class of the tenth and eleventh centuries became absorbed by the Slavs; the trade routes ceased to be under one control and gradually fell into desuetude.

In addition to the Viking raids there was also a northward movement. King Alfred added to his translation of Osorius a remarkable account of Othere or Ottar, a Norwegian who "dwelt farthest north of all the Norwegians".[1] Othere sailed north as "he wished to find out how far the land extended due north and whether any man lived north of the waste tracts". An explorer for the sheer fun of it, he is the first after Pytheas, twelve hundred years earlier, of whom we know, whose travels rolled back the edge of "the northern mists". We are given a picture of a pastoral economy in the north with hunting, fishing, whaling and fowling to add to the wealth of the people and to pay taxation demands.

Before the Norse settled in Iceland monks from Scotland and Ireland had established monastic centres and the Landnámabók refers to former priestly sites. The Norsemen went to Iceland after they had been long settled in the Western Isles where undoubtedly they heard of the northern island. Possibly the sites of Papós and Kirkeby had been deserted before the Norse came or possibly the Irish priests were killed by the immigrants; yet in Iceland the Celtic element in the population is considerable for thralls were taken and this stock is now firmly intermingled with the Scandinavian element. Likewise in the Færoes there are Celtic place-names, e.g. Dímon (Celtic *dímun*, double-neck), which must have been adopted, along with Celtic agricultural terms from the Celtic settlers, who introduced the sheep which gave the Norse name, "sheep-islands", to the archipelago.

The range of the Vikings was wide and ran from the Black Sea in the south-east to Spain, Iceland and North America, while their

[1] Othere's home is believed to have been in the region of Malangen Fjord, north of Narvik.

connection with the poorer land of Finland became more tenuous.[1] The driving force of this movement was immense. The immediate effect on Scandinavia was the bringing back into the area of loot from richer lands and the creation, among the Swedes, of a merchant class. Volume V of *Viking Antiquities in Great Britain and Ireland* lists British objects, most of them from Scotland and Ireland, found in Norway and this reveals how much the Vikings took from the

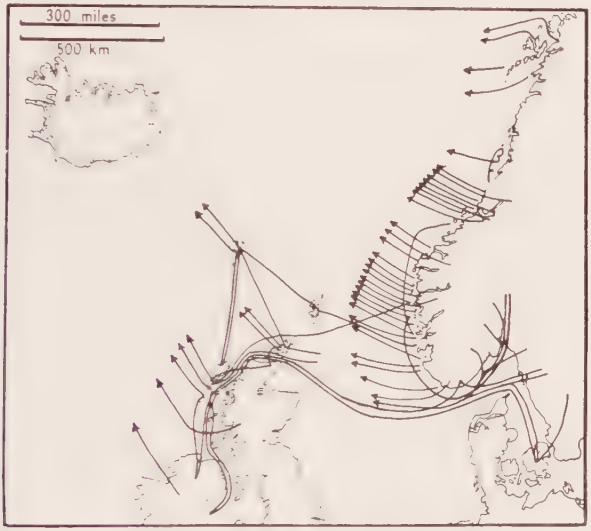


FIG. 32.—MIGRATIONS TO ICELAND.

For identifiable home areas an arrow indicates an emigration of a man and his household and also whether, from the information available in the saga records it was direct or *via* the British Isles or Færoes. Dots indicate settlement points in the new homeland.

Based, by permission, on detailed manuscript map by Per Fett, Bergen Historical Museum.

Celtic peoples. It was a period of spectacular progress: place-names show that there was clearing of the land for agriculture on a scale not known before or since, bog-iron was smelted in quantity and soapstone ware was exported from Norway. Graves were large, the biggest ever known in northern Europe, and bodies buried with their goods and chattels give a rich view of the daily life of the time. In the well-known ship burials are found silk and gold-thread fabrics, tapestries, the gear of the ship, farm equipment and weapons along with the carcases of horses, oxen and dogs. In Iceland too,

[1] Coins found in the Viking hoards include English, German, Italian, Hungarian, Byzantine, Russian and Arabic.

which was settled from the end of the ninth century to about 930 A.D., there are found these ship burials but their contents, in a poorer environment, are not so lavish.

While the Norsemen ventured south, to become absorbed in the population of England and of France, the majority sailing from Hjeltefjord[1] near Bergen chose northern regions to seek homes beside fjords and mountains, where they could draw on pastures and fisheries for a living under the same skies as in Norway.

A.C.O.] [*September, 1953*

FIG. 33.—GULATHING SITE AT EIVINDVIK, NORWAY.

Eivindvik, near the entrance to Sognefjord, was the site of the Gulathing. The gathering, for judicial purposes, was held here from the 940's until 1300 when it was moved to Bergen. Representatives from Hordaland, Rogaland, Fjordane, Sogn, Agder and Sunmöre met in the field in the left foreground.

The ships in which the Vikings sailed are known both from the burial sites and from pictured stones and coins: most of the voyages would be made in the "round ships", not in the great warships which were less seaworthy. While in the early Iron Age vessels were large—one excavated is 75 ft. (22·84 m.) long—they were structurally weak and the later Oseberg (*c.* 840) and the Gokstad (850-900) vessels were much stronger in the keel and planking. The mast was a single fir or spruce trunk and the sail of wadmal (coarse wool) or linen while in addition oars were provided; the later vessels had

[1] Hjaltland is the old name for the Shetland Islands.

fifteen or sixteen rowing holes on each side. Besides the warships the Scandinavians had more seaworthy merchant ships, with higher sides, which could reach Iceland. Certain similarities which occur between East Mediterranean and Scandinavian ships suggest that the contact was by the navigable rivers which almost connect the Baltic and Black Seas but these similarities are not so great as to detract from the Scandinavian contribution towards the evolution of sea-going ships. The detailed knowledge of maritime life which originated in Scandinavia was passed to western Europe and many of the terms used to-day in ships have a direct linkage with the Old Norse words. Coastal navigation was effected from landmarks and in open sea from the sun and the Pole Star. During cloudy weather away from land the course could be determined by the run of the long ocean swell or by the flights of birds returning to their nests. The terms of the compass are interesting; while they had the primary points they referred to the north-east as "land-north", i.e. in relation to the Norwegian coast, and to the north-west as "out to sea north" and these terms were retained even after their significance was lost when navigating from Iceland. The standard measure of distance was "a spell of rowing", i.e. 6 or 7 miles (10 km.) and larger distances by "a day's (i.e. 12 hours') sailing". The times given for going from Cap Stad in Norway to the Horn in Iceland show an average speed well within the capacity of the copy of the Gokstad ship which sailed from Norway to America in 1893. Unable to sail against the wind the vessels were of most use in the most favourable seasons of spring and autumn and the vessels were laid up for tarring in the winter and were kept under cover.

Following King Alfred's record of the north the next noteworthy account is that by Adam of Bremen who in a history of the Church in the north written by about 1067 A.D. gave in his fourth volume, *Descriptio insularum aquilonis*, a valuable account of the lands and the people even though he incorporates with equal weight, in true mediæval fashion, both legend and fact. Sweden he describes as fertile and with many cattle for "it is most favoured with rivers and forests". The lands were periodically savaged by Lapps. With reference to Norway he writes: "Nortmannia is on account of its stony mountains or its immoderate cold the most unfertile of all regions, and only suited to rearing cattle. The cattle are kept a long time in the waste lands, after the manner of the Arabs. They live on their herds, using their milk for food and their wool for clothes. Thus the country rears very brave warriors, who, not being softened by any superfluity in the products of their country, more often attack others than are themselves disturbed . . . consequently forced by their lack of possessions, they wander over the whole world and by their

piratical expeditions bring home the greater part of the wealth of the countries."[1]

After the settlement of Iceland voyages were made to America and without entering into the controversy as to whether the Norse entered Hudson's Bay or skirted the Labrador coast it is certain that they later went to America for timber. The Western Settlement of Greenland was found abandoned, after a period when the climate had seriously deteriorated and the Eskimo had moved south. Perhaps the Norse settlers had been exterminated or perhaps, as is now suggested by recent archæological work, they migrated, and, if so, it must have been to America for there would have been records if they had returned eastwards to other settlements. The Eastern Settlement died out later and here, too, no one knows the story of the end. May it link the Kensington Stone found in Minnesota in 1898 and carved with runes which date it to 1362 A.D. and recording a story now known to be basically possible? Emigrants from the Scandinavian peninsula opened the northern seas, but the knowledge of routes was forgotten and the way had to be rediscovered by John Cabot and other explorers, centuries later.

[1] Adam de Bremen, iv, 30, quoted by F. Nansen in *Northern Mists*, Vol. II, p. 170.

PART II

REGIONAL GEOGRAPHY

CHAPTER 6

FINLAND

59° 30′–70° 5′ N. (1950)
19° 7′–31° 35′ E. (1950)
[19° 7′–32° 48′ E. (1938)]

INTRODUCTION

Finland,[1] lying between the U.S.S.R. and Scandinavia (*sensu stricto*) and between the Baltic Sea and the Arctic Ocean, is a transitional area both structurally and climatically as well as in relief, fauna, flora and ethnography. Its area is 129,619 sq. miles (337,009 sq. km.), of which 9·4 per cent consists of water; the territory surrendered to the Soviet on 12th March, 1940 and 19th September, 1944 was 17,011 sq. miles (44,058 sq. km.). The significance of this republic, which has been since 1917 the most northerly state in the world, is appreciated when the extent of European territory between 60° and 70° N. is considered: while Finland has only one-seventh of this area it has over one-third of the population. Compared with the British Isles, the area of Finland is found to be slightly larger but its population is only one-thirteenth as great. The area of the State, compared with its population, is one of the problems of its administration, for this northern republic was, in 1938, only exceeded in Europe in area by the U.S.S.R., Germany, France, Spain and Sweden, while its population was smaller than that of all other European states except Norway, Eire, Iceland and Albania. With a population density of about 13 persons to a square kilometre, compared with scarcely 11 in Norway, two in Iceland (the only two European states with a smaller density), and forty-six in Europe, Finland's problem is that of a sparsely populated terrain stretched along a north south axis covering over 10 degrees of latitude (720 miles). On the east lie the regions of Karelia and the Kola peninsula which are physically one with Finland, and the boundary separating them from Finland is a poor one with its main strength in the negative, repelling nature

[1] Most place-names in Finland have two forms:—Finnish and Swedish or German. The Finnish form is used in this book (with the alternative in brackets).

FIG. 34.—BOUNDARIES OF FINLAND SINCE 1323.

The stippled areas represent gains of territory from the previous date and the ruled areas losses; Finland has had more political boundary changes than any other northern country in the last two centuries.

Based, by permission, on *Atlas of Finland*, 1925, Plate 38, No. 1.

of the vast peat-bogs and lakes. Unlike the other Scandinavian countries, Finland has had, in historic and recent times, relatively frequent and important boundary changes. This can be attributed to the nature of the terrain and to the fact that the country has been on the fringe of powerful expanding nations, first Swedish and then Russian, both of which have sought adjustments. Furthermore, at various periods there was an expansion of Finnish influence beyond the legal limits, particularly to the north, and later treaties demarcating the frontier took cognisance of such expansion. Figure 34 summarises the changes in the frontier since the first formal treaty, which was that following the Swedish crusades.

GEOLOGY

The Archæan rocks which form the framework of Finland were long since peneplaned; this peneplane was later covered by the great ice sheets which besides leaving superficial deposits have scored and gouged the surface. Most of the solid rocks, among the most ancient in the world, have been turned to crystalline schists after intense metamorphism: originally some were sediments and others igneous rocks but their former character has been totally lost. Intruded into these rocks are great bosses of granitic material of which the southern are readily eroded. As well as the "Fundamental Complex" rocks found in the east there are, round Oulujarvi (Uletrask), later rocks of Pre-Cambrian age, but these also are much altered and their position in the stratigraphical column is uncertain because of the complicated thrusts and foldings which have occurred. Cambrian rocks also occur; those of the south are of little value economically, but those of the north contain ores with workable contents of nickel and copper. With the complicated tectonic movements and the immensely long period of erosion, correlation between the solid geology and the relief is slight but there is a tendency for the granite outcrops to form small rounded hills, and the schists elongated ridges known as *vaaras*. The hill tops are frequently formed by erosion-resisting quartzites. Where the hills are not tree-clad they have, although not high, a fjell appearance and are known as *tunturi*.

Finland is blanketed by a cover of glacial deposits and peat, and these modify the surface and control, in large measure, the human utilisation. Most important of the quaternary deposits is the ground moraine, laid down on the ice-polished rock, which covers four-fifths of the country. Many of the moraines are in the form of drumlins with a core of solid rock. Unlike the moraines of the North European plain those of Finland, which are nearer the source of the

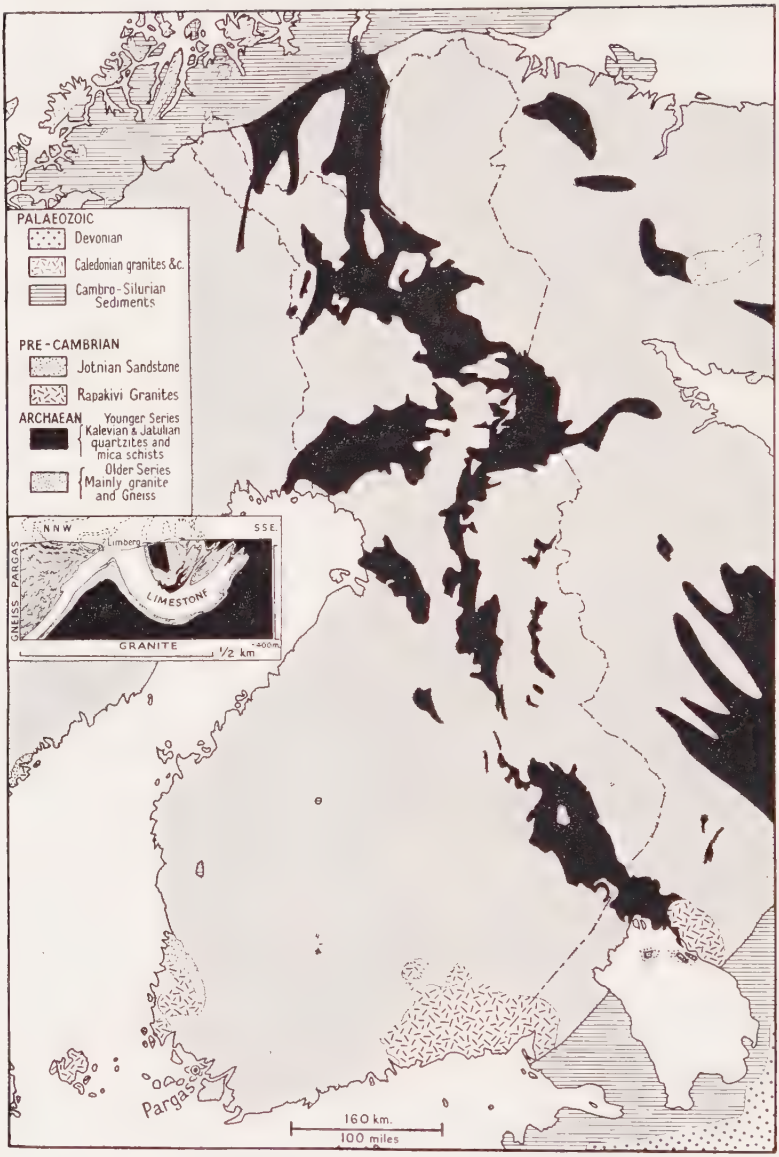


FIG. 35.—SOLID GEOLOGY OF FINLAND.

The Archæan and Pre-Cambrian rocks are flanked by the Cambro-Silurian sediments of Russia and Norway. Inset is a cross-section of the Pargas limestone working to show the complexity of the folding.

Based, by permission, on *Atlas of Finland*, 1925, Plate 8. The inset is from A. T. Metzger, "Kalksten och Kalkindustri i Skärgården" in *Skärgårdsboken*, Helsingfors, 1948, p. 694.

supplying material, consist of gravels, except in the Karelian isthmus and locally in Ostrobothnia where they are clayey. The movement of the ice was generally from the north-west and so there is an exten-

FIG. 36.—MORAINES AND ESKERS OF FINLAND AND NORTHERN SWEDEN.

The lines of the eskers and the great Salpausselkä moraines are reflected in the lake pattern of Finland (see Fig. 38).

Based, by permission, on *Atlas of Finland*, 1925, Plate 9, E. Granlund and G. Lundqvist, "Karta över Norrlands Lös a Jordarter", *Sveriges Geol. Unders.*, Ser. C, Nr. 457, 1947, etc.

sion towards the south and east of the influence of the solid geology; it was through a study of the lines of movement, as indicated by trains of erratics, that various ore-bodies such as the Outokumpu copper were discovered. Associated with the ice-sheets are long

hog-backed eskers (known as *harju* in Finland) which parallel the line of ice movement. These remains of fluvio-glacial action, as well as those formed along the front of the ice during stationary periods, have given variety to the landscape and, being permeable, have provided dry routeways. During the period of marine transgression, before the removal of the ice-load led to uplift, clay deposits were laid down in southern Finland south of the Salpausselkä marginal deposits; and post-glacial deltas of river alluvium, now raised above the sea, were formed in Ostrobothnia. The southern coastline is

Photograph by courtesy of Finnish Embassy, London]

FIG. 37.—ESKERS IN THE WOODED LANDSCAPE OF THE LAKE PLATEAU.

accidented with many rocky islands as well as those formed by partly submerged moraines.

Suomi, the Finnish name for Finland, means "land of marsh" and this title is well warranted, for with about one-tenth of the surface water-covered the country has an exceptional character: the only comparable profusion of lakes is to be found in the similar shield region of North America. These lakes are mostly of the rock basin type and have been eroded by the ice movement but their pattern is also affected by the faulting to which the region has been subjected. There are two principal alignments of the faults—a greater from

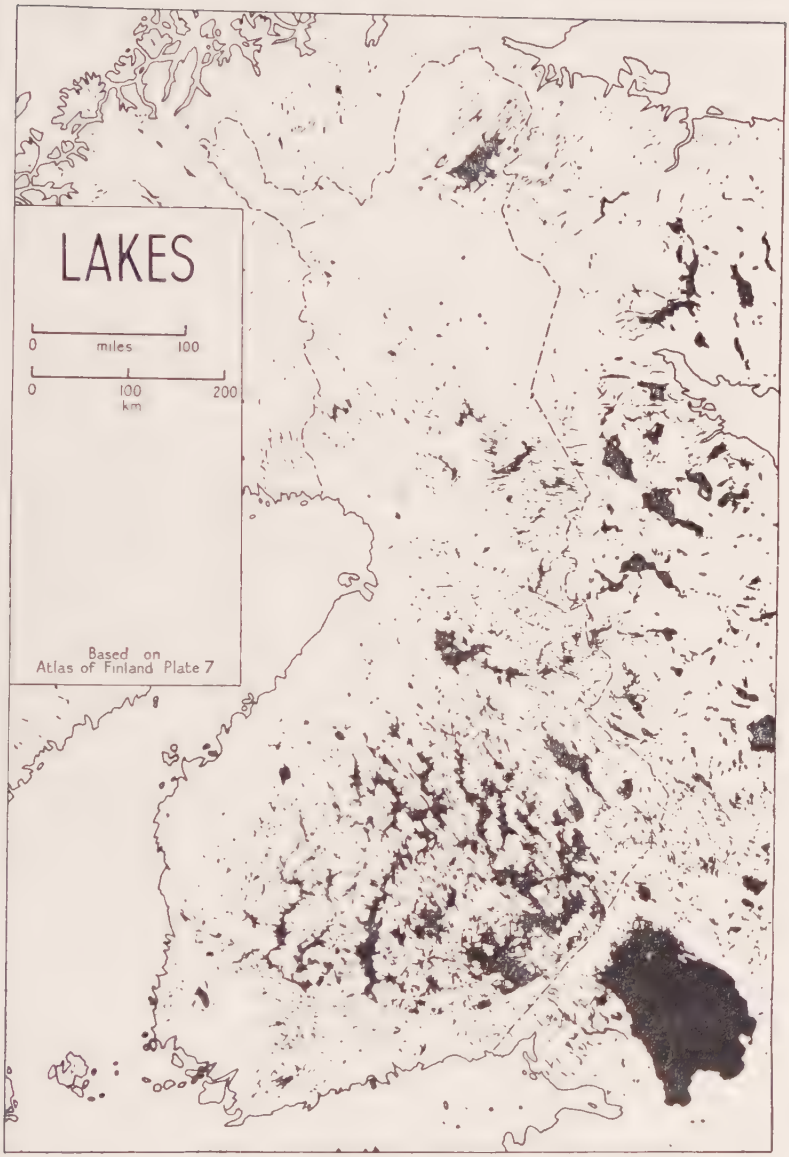


FIG. 38.—THE LAKES OF FINLAND.

All fresh-water surfaces, other than rivers, are shown in black and the significance of the regional name *Lake Plateau* is apparent.

Based, by permission, on *Atlas of Finland*, 1925, Plate 7.

north-west to south-east, and a lesser at right angles. As in the fjord country of Norway and northwest Scotland, the ice has picked out the structural lines of weakness. The presence of these lakes, besides adding to the charm of the landscape, has permitted the opening up of the forests by providing waterways as well as by stabilising run-off, and so encouraging the development of hydro-electricity. The chief region of lakes is the plateau of the south and the edge of this is marked by a line of rapids which provide a source of power. Along the borders of the lakes, where there is not a marshy fringe, settlements have grown up. In addition to the fresh-water areas are many tracts of swamp. If all lands bearing even a little peat cover are so classified the land describable as swamp amounts to one-third of the total land area. Fortunately, two-fifths of such land could be made fully productive for tree-growth by drainage.

CLIMATE

The climate, though modified by the great extent of the lakes and gulfs, is chiefly controlled by two contrasted influences—the warm Atlantic Drift and the air-mass of continental Europe. The proximity of the interior plains of Europe and the lack of a mountain barrier result in domination by the latter influence and the whole of Finland is frozen in winter. The severity of the cold and the brackish nature of the adjoining gulfs of the south mean that of all the numerous ports on these shores, only Turku (Åbo) and Hanko (Hangö) can be kept open easily in winter. North of the Arctic divide the influence of the North Atlantic Drift is felt more and the shores of the Arctic Ocean have temperatures approaching those of areas 720 miles (1,160 km.) to the south. The continental nature of the climate is also seen if the average temperatures for July are compared with those of Scotland: although the whole of Finland is north of the mainland of Scotland, temperatures are higher. The hours of daylight are long in summer, so partly offsetting the short season, but in every month of the year there is a liability to frost. To counteract a tendency to the formation of frost pockets farm clearings in the forests are sometimes made with the long axis parallel to the direction of the prevailing summer winds, in order to reduce the accumulation of stagnant cold air. Precipitation, although generally above the mean for the Arctic regions, is small, but the evaporation rate is low and the fall is adequate for plant growth. Although most of the precipitation comes in the summer the snowfall is considerable, and this is an advantage in that the early summer floods help timber floating, whilst in winter movement is easy across the snow surface. Only in the south-west does the snow lie for less

than a quarter of the year, and the length of the winter plays its part in the whole economy of Finnish life.

SOILS

Soils in Finland, almost exclusively podsols, tend to be leached by the saturation which results from the slow rate of drainage following the vast summer melt of the snows. The best soils are the post-glacial marine clays and silts in the littoral zone, but these only occur in 3 per cent of the area of Finland. The forest lands generally have soils so meagre and stony that it would be useless to attempt agriculture. In the interior, cultivation is hindered by the rocks in the boulder clay which require removal before the land can be ploughed, The acidity of much of the soil causes the precipitation of iron compounds as a hardpan layer or as bog iron. Most of the field drains are open and their condition has deteriorated through shortage of labour during and after the war years. The presence of these open drains, some 33 ft. (10 m.) apart, wastes much of the improved land; some estimates place the loss as high as 10 per cent, and their replacement by tile drains would greatly increase the area of farm land and, at the same time, reduce the weed growth.

VEGETATION

By far the greater part of Finland has a climate suitable for coniferous tree growth, with natural regeneration of the forest, and only on the coasts of the Arctic Ocean and on Fisher Peninsula was the original vegetation near sea-level true tundra. Rising above the general altitude, however, are low hills and these, particularly in the north, have a rather more extreme climate and so lack trees. Elsewhere, the tree cover is far from continuous for bare rocks and bog are frequent. The indefinite drainage of so much of the country helps to waterlog the ground, and so to encourage peat growth in all but areas of uneven surface. This saturation of the soil leads to a loss of fertility and thus further inhibits tree growth. Many of the open swamps and fens have scrub pine growth while other swamps have slow-growing spruce. Also set in the forest are lands described as meadow, but these are mostly bogs with a sedge growth which gives them a grassland appearance although some, particularly in the tracts of limestone, are true meadows. Forest lands in the past were cleared for cultivation by burning, and such sites, if abandoned for agriculture, are either marked by meadows and alder thickets, or have regenerated to pine and birch stands. Finnish botanists divide the vegetation into belts from south to north as follows: oak, maple, linden, southern conifer, northern conifer, Lapland conifer,

birch and alpine zones. These descriptions, as regards the three southern belts, are tendentious in that they suggest the character of the vegetation; all they should imply is that these trees will grow as far north as the zones extend. With both vascular plants and mosses the number of species decreases northwards into the regions of more severe conditions, both of climate and soil poverty.

HISTORY OF SETTLEMENT

The movements of people across what is now Finland have left many traces although fortunately the problem of minorities is not now one which produces intense feelings. It is believed that the

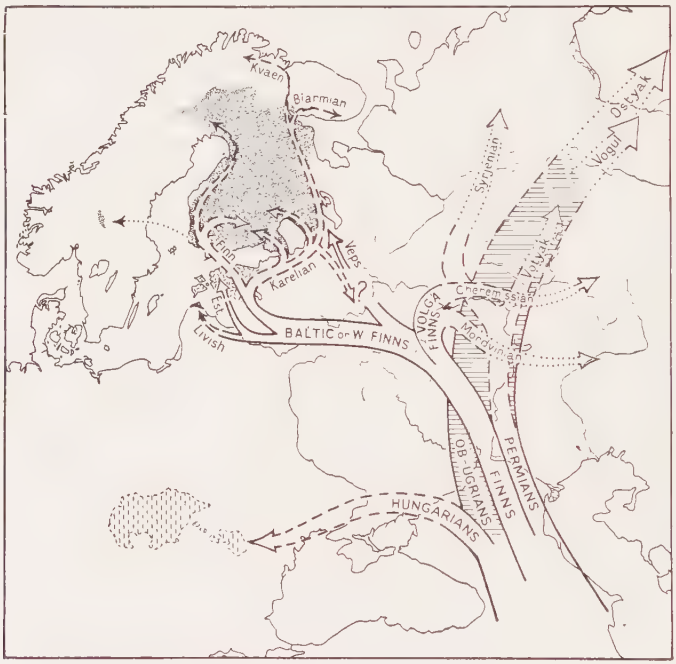


FIG. 39.—FINNISH-UGRIAN MIGRATION.

The peopling of Finland can best be traced on philological evidence. This map, based on the evidence presented by R. E. Burnham (*Who are the Finns?*, London, 1946), indicates the connections with south-east Europe and the possible routes of migration from Asia.

Finns, who are unrelated to the Teutons, Slavs or Mongols, began their wanderings between the Urals and the Volga; the Magyars turned south to Hungary and the Finns north to Estonia and so to Finland. Some entered the country along the Leningrad–Viipuri

(Viborg) corridor, others across the swamps north of Lake Ladoga, while still other groups crossed to the archipelago of the Gulf of Finland. The language is of Ugro-Finnish stock; it resembles Estonian and early Magyar, in having very complicated grammar and syntax, and in the absence of articles, of gender and of the letters *b*, *c*, *f*, *q* or *w*; but fortunately it is easy to pronounce from the spelling. The early Finns arriving in the country were hunters and trappers and it was not until the eighth century that they settled, driving the Lapps northwards. There were three main regions of permanent occupation—Suomi in the south-west, Häme in the centre and Karelia in the east—and each was organised tribally as the people became tillers. Anthropologically the Finns are a tall, fair stock, with an average male height of 65–67¾ in. (165–172 cm.). The Nordic element is seen in the oval cranium, in the west and south-west, while the East Baltic shorter and broader cranium is found in east and north Finland. Analogies have been drawn between the subsequent history of Finland and Ireland: both were invaded, Finland by Eric the Red and Ireland about the same time by Henry II, and in both cases a new stock was created (Swedo-Finn and Anglo-Irish) and the settler-invaders[1] swamped the native culture although the original strain, temporarily obscured, was maintained and has made an assertion in the last hundred years for economic equality and political power. The analogy must not be pushed too far, for the English conquerors were misguided while the Swedish were wise in their generation and have left no Finnish problem for Sweden.

In 1154 A.D., the first Swedish crusade converted the Suomi Finns, and the second crusade of 1249 led to the forcible conversion to Christianity of the Häme Finns and at the same time established Swedish rule in Finland. As a result of this political control, Finland became the scene of strife between the Russians of Novgorod and the Swedes, and when the battleground shifted to Karelia in 1293 the third crusade "converted" the Finns of western Karelia. The Treaty of Pähkinäsaari (Nöteborg or Schlusselburg, key of Finland) in 1323 fixed the boundary between Swedish and Russian spheres of control. The Swedish conquest was not followed by any dramatic colonisation and only a few nobles acquired estates and a handful of traders settled, for Sweden itself was not yet organised. In 1362 Finland became an administrative province of Sweden and participated in the royal elections.

The local form of administration was allowed to remain while to

[1] The vikings, called by the Finns *Ruotsi* (rowing men), early raided Finland and the Finnish name for the viking settlers of Kiev and Novgorod became corrupted to *Rus*, hence the modern name of Russia.

the Council of Tampere (Tammerfors) was given the monopoly of trade in Lapland, and this led to the conquest of the north being carried out for Sweden by the Finns. The Union of Kalmar, 1397, which united Sweden, Norway and Denmark, gave Finland some autonomy such as the right to issue currency. The conquest had some repercussions on development and did not remain a token control: the Swedish power saved the Finns from the German Knights of the Sword, from the Tartars who conquered Novgorod and from feudalism, since the Swedes had a free peasantry. Swedish contacts brought them into the orbit of western civilisation and taught the Finnish people agriculture and metalcraft. With the Reformation Finland became Lutheran and there grew up the tradition of the long journey by cart and boat to church—the centre of parish life.

The wars waged by Gustav Adolf forced his chancellor, Axel Oxenstierna, to bleed the country of man-power and, while courts of justice and a university were created, the heritage was whittled away by grants of land and revenue to victorious generals of the Swedish army. In the following century the war between Sweden and Russia saw the ravaging of Finland by Peter the Great and this war was followed by the ceding of Käkisalmi (Kexholm) and Ingria and the province of Viipuri (Viborg) to Russia in 1721. These wars and the famine of 1696, when a third of the people died, reduced the population to under a quarter of a million. In the second half of the eighteenth century there was a recovery and new livelihoods arose from the reclamation of waste land and from the exploitation of the forest wealth, so that by 1800 the population was trebled. But with prosperity and the political strivings of the Czars, Finland became a pawn in the Napoleonic schemes. The Russians captured the country and the Swedish control of five and a half centuries ceased with the Treaty of Hamina (Fredrikshamn) in 1809. The Russians returned Viipuri (Viborg) Province to Finland three years later. For a century the Grand Duchy of Finland had a considerable amount of autonomy but in 1907 there commenced a period of "Russification". Following the industrial revolution of the nineteenth century the population of the cities had increased, and along with the creation of a great group of landless labourers, this led to a feeling of unrest. After the Russian Revolution civil war raged in Finland with Germans fighting in the south against the Soviets. The Germans had intended that Finland should become a province of Germany but the Allied victory stopped this plan. In 1918 Finland, spared conscription for the Russian armies and grown rich by the profits of a war in which she had not played an active part, was the poorer by the loss of thousands of men killed in the civil war but richer by independence.

The immediate post-war period was occupied by consolidation of boundaries. Karelia was the chief problem. As early as the fourteenth century it had been an area of dispute until it was divided between Russia and Finland in 1323. The Karelians in the east became numbered among the Catholic serfs of Russia while those in the west remained a free peasantry. The opening of the Murmansk Railway during the First World War meant that the area had for the first time become of considerable strategic value. After Eastern Karelia had been fought over by the Soviets and the White Russians it was recognised by Finland as part of the U.S.S.R. under the Treaty of Dorpat (Tartu). Finland also gave up two frontier parishes which she had acquired in 1918, but in return the Soviets ceded Petsamo and an approach corridor. There was also strong feeling over the Åland Islands. Linked to Finland by the Turku archipelago and separated from Sweden by a deep channel some 30 miles (48 km.) wide, these islands are geographically and historically Finnish but ethnographically Swedish. First recognised by Napoleon as the "key to Stockholm" they had been heavily fortified during the First World War. The islanders wished to join Sweden but, on appeal, the League of Nations ruled that, after demilitarisation, they were to be administered by Finland, but were to be given a considerable degree of autonomy.

The resultant Finnish republic included within its boundaries a Swedish-speaking population in the south-west, amounting to one-tenth of the total for the country, and appreciable numbers of Germans in the south, Russians in the east, and Lapps in the north. Nevertheless there have not been the minority problems which have beset other creations from the First World War. Zachris Topelius wrote of his compatriots[1]: "The general traits of their character are: hardened, patient, passive strength, resignation: perseverance allied to a certain obstinacy: a slow contemplative way of thinking: an unwillingness to become angry, but a tendency, when anger has been roused, to indulge in unmeasured wrath: coolness in deadly peril, but caution afterwards: taciturn reticency, alternating with a great flow of words: an inclination for waiting, deferring, living for the day, interrupted sometimes by unreasonable haste: adherence to the old and well known, an aversion to anything new: attention to duty: law-abiding habit of mind: love of liberty; hospitality; honesty . . .". The more sanguine, adaptable Swedes married the Finns, and the Swedo-Finns found along the western coastal districts are not quite Swedish or Finnish in character. The Russian minority in the east no longer exists, as the territory was surrendered to the U.S.S.R. in 1945.

[1] Quoted J. H. Jackson, pp. 20–1.

POPULATION AND THE LAND

The adverse environment at first prevented a great increase of population but after about 1800 numbers rose so rapidly that even with the growth of industries the population was beyond the resources of the territory to maintain. As a result mass migration occurred to the U.S.A., especially to the hay and dairy region of the north, where the environment most resembled that of the homeland. In the first twenty years of the life of the republic the population increased by 15 per cent as compared with a European increase of 10 per cent. While Finland has an overall density of settlement equivalent to that of Minnesota there are regional variations: the north is least settled and the clay lands of the south, the first to be occupied, most densely peopled. The increase of population in the last century was associated with the creation of crofts on the larger farms, with the rise of industrial cities, and with the colonisation of the northern lands. At the time of the first census in 1749 the north, even as far south as Tampere (Tammerfors) and Savonlinna (Nyslott), was almost uninhabited. To-day the Lapps of the north only number about 2,350 and are centred in the Enontekiö, Inari and Utsjoki districts. The Swedish stock populates two main regions: the northern one is a coastal strip 12–31 miles (20–50 km.) wide centred on Vaasa (Vasa) and the southern one is the south-west coastal zone, including the Åland Islands. While the number of Swedish speakers is increasing their ratio in the total population is decreasing; from 16·3 per cent in 1749, to 11·6 per cent in 1910, 10·1 per cent in 1930 and 7·4 per cent in 1960. Most of the Swedes are rural dwellers although some are found in Helsinki (Helsingfors).

The industrial revolution which started in the 1860s upset the social balance. Previously the peasantry had mainly owned the land; as in Sweden feudalism never obtained a hold, and there were few large estates. There were many holdings of some 50 acres (20 ha.) of improved land with 500 acres (200 ha.) of forest. This was sufficient to support a yeoman-freeholder family, in which the husband and boys worked the holding for long hours in the short summer, while the wife and girls tended the cows and pigs, spun and wove the wool and flax produced and ground the grain. The children worked on the farm and were settled in a cottage when married: in short, it was a patriarchal, classless system. As the population increased, younger sons reclaimed strips of forest and the landlords in return for the crofts (*torpparit*) received work and produce. Unfortunately the 1860s brought a series of cold, wet summers and starvation attacked yeomen, cottagers and crofters alike and their natural tendency to increase their holdings was obstructed by the landowners

who were just realising how industrialisation was enhancing the value of the forests. Moreover, few new crofts were created and there was an increase in the landless class (it numbered 207,000 families in 1901) which tended to flow to the industrial areas. Others emigrated and by 1893 about 5,000 a year were leaving; in the generation from 1893–1930 one-third of a million persons left Finland, nearly half from Vaasa (Vasa) province. It is true that large numbers returned home, but of these emigrants and their descendants 350,000 live in the U.S.A. and 65,000 in Canada; this compares with 4·4 million persons in Finland in 1950. The drift to the towns is partly concealed in the official statistics by the classification of market towns as rural districts, while some rural districts have considerable industrial centres which are not separated for statistical purposes. Corrections applied to the statistics suggest that under two-thirds of the population can now be regarded as rural and that the absolute number, as well as the ratio, of rural workers is decreasing, but there is not, as yet, appreciable rural depopulation, though a shortage of farm labour does exist.

Analysis of Population

	1913	1930	1940	1950	1960
Percentage of working population:					
Industrial workers . . .	12	17	21	32	38
Transport	5	8	5	6	7
Agriculture and Forestry . .	66	60	51	39	29
Percentage of total population:					
Urban population . . .	16	21	23	26	39

To satisfy the unrest of the landless class the *Lex Kallio* of October 1927 provided State aid for the purchase of holdings in hitherto uncultivated land. This law aimed at providing small farms of 50 acres (20 ha.) of improved land and cottage-holdings with 5 acres (2 ha.) of improved land. Legal expropriation only affected estates of over 500 acres (200 ha.) and even then there were graded limits. In twelve years the *Lex Kallio* increased the area of improved land by two million acres, while the increased agricultural productivity made Finland nearly self-supporting in food supplies. By 1937 one family in three owned land as opposed to one in four in 1910. Nevertheless, even in 1949 only 8 per cent of the land area was cultivated and this low proportion is due to the poor soil and severe climate. The cultivated land is concentrated on the Ostrobothnian Plain or on the cleared moraines north and south-west of Lake Ladoga, so that the loss of the latter to U.S.S.R. has gravely upset the balance of food supplies. The cultivable tracts are generally small lakeside lowlands

set in a forest-clad rolling plateau. This has a twofold disadvantage, in the creation of conflict between agrarian and forest interests and in the isolated situation of the farms, particularly at the periods of ice formation and dispersal when the waterways cannot be used. The humidity and the low temperature produce a verdant grass growth but a major handicap in the drying of the hay is the heavy cloud cover, which necessitates the use of drying poles. Arable farming is difficult and so the farmers early turned to dairy activity. The Swedish farmers had acquired most of the better land, so at the time of increase of population the Finnish farmers had to use the poorer lands and in 1894 a Society was founded for research into the cultivation of bog lands, in which sphere considerable progress has been made.

FARMING

There are three main types of farms:

(*a*) Primitive—in E. and N.—self-sufficient, with a few animals (mainly horses and cows).

(*b*) Transitional—S.E. and S.W. and on Ostrobothnian Plain—Horse-drawn machinery and co-operatively owned tractors etc.

(*c*) Modern—rare, as capital is scarce—The majority are State experimental farms which undertake enterprises not immediately profitable: e.g. swamp reclamation, animal and plant breeding.

The typical farm layout is a single-storey log farmhouse set in the log-built steading, thus contrasting with the plank-built buildings of the towns. The houses are situated near the water-supply and are adjacent to the infield of improved land; beyond, the grazing lands extend to the forest edge. The main room is the kitchen with an immense log-burning stove round which life centres in the long winter months. Between the widely spaced villages are scattered isolated farms which have to be nearly self-contained.

If the growing season is taken as the number of days on which the average temperature exceeds 41 F. (5°C.) it varies from 110 days in the coldest parts of Lapland to 170 days in the south, while the accumulated temperatures above 41°F. (5°C.) in this season amount to 540–720°F. (300–400°C.) near the Arctic Circle and 1,980–2,160°F. (1,100–1,200°C.) in the south.

The ripening of crops may be prevented if there is a hard spring, and famine years have been caused by frost damage at harvest times. Famine yields occur on the average one year in five and are generally due to unusual cold, although excess or deficiency of precipitation has been responsible on occasions, particularly in the south where

Photograph by courtesy of Finnish Embassy, London]

FIG. 40.—AGRICULTURAL CLEARING IN SOUTHERN FINLAND.
A typical farming community set in a forest clearing.

Growing Season and Crop Requirements

Period of Growth

Crop	*Beginning*	*Length in days*	*Average Temp.*		*Accumulated Temps. above* 41°F. (5°C.)	
			°F.	°C.	°F.	°C.
Potatoes	June 3rd	110	48·8	9·2	900	500
Barley		115	49·7	9·8	990	550
Winter rye		120	51·0	10·5	1134	630
Turnips	May 25th	135	51·8	11·0	1440	800
Spring rye	„ 14th	135	52·1	11·2	1476	820
Spring wheat	„ 10th	150	52·9	11·5	1710	950
Peas	„ 7th	155	53·2	11·8	1980	1100
Sugar beet	„ 6th	165	53·6	12·0	1980	1100

(Based on *Finland Year Book*, 1947, p. 154)

temperature conditions are less marginal. Unfortunately, a series of warm years, as in the decade before the war, tempts agriculturists northwards, with disastrous results when less genial conditions recur.

The crops include rye, oats and barley and the acreage under these has increased since the supply of cheap duty-free Russian grain was eliminated at the outbreak of war in 1914. To stimulate grain production premiums have been given for the breaking in of new land. With the increase of livestock the oats acreage has exceeded that of rye, but the latter cereal remains the bread grain, for wheat is only grown experimentally in the south-western quadrant where climate conditions are most suitable. Barley, able to take advantage of the long summer days for growing, is found close to the Arctic shore far north of the limit of oats. Potatoes, the chief root crop since their introduction in 1730, are vulnerable to frost damage. Market gardening has shown signs of increase, which is desirable in order to vary the winter diet as well as to feed the growing towns.

The production of hay is the main interest of the farmers and, taken from the natural grasslands, it forms the mainstay of the dairy industry, which is based on crosses between Ayrshires and the native breed. As far back as the twelfth century butter was exported *via* Lübeck and then for a period through Sweden, but now most of the exports are shipped direct although some are sent *via* Denmark. The cheese export is increasing but the tonnage is small. The increased production of grain, cheese and butter was obtained at the price of increased use of imported fertilisers and feeding stuffs and this proved a handicap during the Second World War. The rise of the dairy industry was stimulated by the increase in agricultural co-operation. The individual dairies are small, as the population is so scattered, but in 1939 85 per cent of the export of butter, cheese, eggs and honey was handled by one central co-operative concern. For centuries Finland has been famous for its horse-breeding. On the rocky areas of the south-west and of the Åland Islands sheep and goats are reared. A subsidiary livestock industry is that of reindeer and these, besides providing the mainstay of the Lapps, are also kept by the Finns as far south as Oulu (Uleåborg). The wolves and lynxes are a menace to the pastoralists, and a bounty is set on their heads. Their retreat was the eastern and northern frontier belts which were little settled before passing to the U.S.S.R.

FORESTS AND FORESTRY

The forest products of Finland control her well-being for they represented in 1961 over four-fifths of the value of the exports. In addition, the forests provide a cash income for farmers otherwise idle through the long winters. The farmers draw firewood and construction and fencing timber from their forest strip and in addition obtain an essential cash return from the sale of wood. In the

south there has been wide clearing of the forests for agriculture but over seven-tenths of the whole land area is still classified as forest. The loss of territory to the U.S.S.R. has now brought the Finnish

Photograph by courtesy of Finnish Embassy, London]

FIG. 41.—FOREST WORK IN FINLAND.

forest area below that in Sweden but she is still the most forest-clad country in the world.

The land surface in Finland can be divided from the point of view of forestry into the following categories:

Land utilisation in Finland

	Million Acres		*Percentage*
	1938	1945	1945
A. Productive forest lands	48·4	42·2	56·0
B. Poorly productive forest lands	13·0	11·3	15·0
C. Cultivated lands, built-up areas, mineral workings etc.	10·7	9·6	12·7
D. Waste land of swamps, rock outcrops and fjelds	14·1	12·4	16·3
TOTAL LAND AREA	86·1	75·5	100·0

(Based on Ilvessalo, p. 15)

By reclamation of swamps and by improvement of poorly productive forest lands it is hoped to increase the proportion of Category A in the table above. Ownership of the forests is divided between private, community, company, Church and State interests but, although the government only own outright extensive tracts in the poorer forests of the north, the whole of the forests are now controlled by legal enactments.

The first recorded export of timber was in the thirteenth century when cargoes were sent *via* Lübeck to England and the Low Countries. Although relatively easy to exploit, the forests were in no danger of overcutting until the industrial revolution and the decade 1860–70, when the wood converting industry expanded fivefold and government controls were removed. The original woodworking industries were situated near the rapids but the introduction of the steam sawmill in 1860 led to a migration of the industry to the coast where the sawn timber could be loaded direct on ocean-going craft; this reduced transport costs, for whilst the logs could be floated to the mills the planks could not be floated to the ships. The average output of sawn timber increased from 85,000 standards for the decade 1860–9 to 515,000 standards for the decade 1900–9. Since 1907 there has been a rationalisation of the industry and now there are fewer, but larger, mills near the coast, but there are still many smaller sawmills inland, nearer their source of raw material.

The productive forests consist of pine (*Pinus sylvestris*, 49·7 per cent of forest land), spruce (*Picea excelsa*, 35·3 per cent), and birch (*Betula odorata* and *B. verrucosa*, 13·1 per cent), with small stands of alder and aspen (1·2 per cent).[1] Larch, the most important exotic tree, is now acclimatised. Fire and cutting have reduced the acreage of pine, for if left to natural regeneration it tends to be replaced by birch and spruce. With a demand for more spruce by the expanding paper industry, afforestation has been carried out from nursery beds, so that in the fifteen years between the two National Forest Surveys the area of forest dominated by spruce increased by no less than 13 per cent. It is probable that in the future spruce will continue to increase in the south but that in the drier north, pine will increase. The pine stands, which provide the raw material for the sawn-timber trade and sulphate pulp, develop on the sandy areas with drier soils

[1] The first National Forest Survey in Finland was carried out in 1921–4, the second in 1936–8, and a third in 1951–3; the labour expended in these surveys is a sign of the realisation of the significance of forestry in Finnish economy. The statistics of forest growth are based on the Survey 1936–8 with recalculations to meet the changes in boundary. Since this survey there have been great changes; very heavy cutting for firewood, reconstruction and reparations in some districts, and virtual cessation of cutting, owing to transport difficulties, in other districts.

and with the hard climate growth is very slow. Spruce, which forms pure stands in swampy areas, provides good sulphite pulpwood and even the short growth can be utilised and this has resulted in a scarcity of young spruce forests. Birch forms pure stands in the north, but elsewhere breaks the monotony of the coniferous forests. Alder and aspen are regarded as "weed growth", but locally are useful for a match industry. The undergrowth of the forests consists of juniper, bilberry and cranberry and, in the drier forests of the north, lichens including "reindeer moss".

Unfortunately, right up to this century forest lands have been destroyed, particularly in the south, by the pernicious system of shifting agriculture, and by burning, and with the prevailing slow rate of growth this has been a serious loss. The age conditions of the forests differ between the north and south: in the north over three-fifths of the trees are older than 1850 whereas in the south over four-fifths are post-1850. The remote northern forests are little exploited, partly because of a fear of altering the climate and lowering the tree line, and partly on account of transport difficulties.

The cutting of the forests is carried out in winter[1] and the logs are hauled across the snow to the stream banks, to be floated down in the early summer: they are *not* placed on the ice for in the turbulence of the thaw they would be pulverised. Transport costs have been reduced by clearing the rivers of obstructions, and by constructing railways, conveyors and roads.

Although Finland's total growing stock has fallen below that of Sweden, in consequence of the cession of territory to the U.S.S.R. and of the clearing of land for displaced persons, she still has the greatest growing stock per inhabitant of all European countries. The growing stock of the forests has been carefully investigated: a summary statement is given below:

Growing Stock in Finland, thousand million cubic feet, including bark

Species of Tree	1922	1938	1951–3
Pine	27·4	24·9	23·0
Spruce	17·0	17·8	18·2
Birch	10·2	10·4	9·7
Aspen	0·7	1·0	1·2
Alder	0·7	1·0	
TOTAL	56·0	55·1	52·7

(Based on Ilvessalo, p. 30, and National Forestry Survey: one million cubic feet equals approximately 28 thousand cu. m.)

[1] Winter is the best time for felling as the wood is driest and dry timber is less attacked by insect pests and floats more easily. In Norway more cutting is now being done in summer (see p. 234 f.n.).

The mean annual growth is a matter of concern and the National Surveys examined this in detail in order to verify that the rate of cutting did not exceed the growth rate; it is estimated that the annual felling quantity is 1,200 million cu. ft. (42·9 million cu. m.) but that this cannot all be realised owing to the isolation of some of the northern growth, and there may be local overcutting.

"Growth-Balance" of Finnish forests, in million cubic feet, "green" but excluding bark

Average of the years	*Growth*	*Felling*
1923–38	1,624	1,448
1935–39	1,624	1,483
1940–44	1,624	1,165
1961	1,660	1,860

(Based on Ilvessalo, p. 43, and Pöntynen quoted in *Econ. Rev.*, 1962:2 Kansallis–Osake–Pankki)

The excessive post-war felling, forced by the need to provide reparations and to clear land for the re-settlement of people from Karelia, drew on the accumulation from reduced cutting during the war. From the timber about 10 per cent is lost by logging waste, loss in floating and by self-thinning. Of the felled timber which is productively consumed, it can be seen from the table that changes of emphasis are occurring.

Utilisation of Timber, by percentages

	Average 1923–8	1938	1946
Industrial raw material . .	44·4	47·8	31·4
Firewood for industry . .	3·1	3·2	9·1
By rural households . .	34·2	30·7	32·9
Exported unmanufactured .	8·4	7·7	4·2
Firing for transport . .	3·6	3·7	9·3
Other uses	6·3	6·9	13·1

The essential demands of reconstruction and reparations have hitherto prevented expansion of the woodworking exports, which are further handicapped by the very high wages and the need, owing to the coal shortage, to use over half of this raw material for firing.

Considerable quantities of the timber are sold as sawn lumber but the amount produced fluctuates rapidly according to world demands. About nine-tenths of the output is normally exported and Finland is a leading supplier on the world market; in 1961 Finland met 13 per cent of international purchases, which compares favourably with U.S.S.R. 13 per cent, and Sweden 11½ per cent. Of the export, normally over two-fifths goes to Britain. There is a tendency to produce more valuable products, such as plywood, rather than mere sawn timber. The first plywood was manufactured in Finland in 1912 and to-day there are twenty-one mills, which export nine-tenths of their produce and meet nearly one-third of world requirements. This rise in the capacity was stimulated at first by the needs for aircraft construction and later by the removal, for a period, of Russian competition. The main customers are the countries of north-western Europe and Japan. The invention of plywood provided a valuable use for the birch, aspen and alder forests of the north and the main potential rivals are the U.S.S.R. and Canada which have similar forest growth. Unlike the sawmills the plywood factories are in or along the periphery of the central lake region. Other timber industries are the manufacture of bobbins, since 1873, from alder (Finland meets nine-tenths of world requirements), and the production of matches; but in the latter manufacture severe competition is met from the large-scale manufacturing units in U.S.S.R. and Sweden. The only timber imports required are special hardwoods for furniture and shipbuilding. The production of sawn timber and plywood is near the limit set by the growth rate of the timber but there is the possibility of some expansion of the other types of timber-using industries. To the skill of her craftsmen was added streamlined design and Finland set the lead in modern furniture: perhaps this may become a more important manufacture.

Destruction of the timber to produce other products has long been carried on and for centuries there has been distillation for tar, turpentine and charcoal but the amount of tar produced has declined for now only the stumps are so used. In place there has come the manufacture of pulp—both chemical and mechanical—paper, cards and wall board. These manufactures, which have greatly improved in quality, depend in part on imports, for sulphur and chlorine have to be obtained for sulphite cellulose production and sodium sulphate for sulphate cellulose. On the other hand, in sawing timber half the volume is wasted; the sawdust was originally burnt but now it provides a cheap raw material for sulphate pulp (kraft paper). Since 1939 cellophane and artificial silk have been manufactured. The scale of the pulp and cellulose industry can be gauged from the fact that in 1960 only the U.S.A., Canada and Sweden were producing

greater quantities, and in the production of chemical pulp for export Finland is now third only to Sweden and Canada.

As in Sweden, societies and schools exist to improve the technique of forestry. In order to retain skilled foresters living conditions have been greatly improved but this has made the extraction of the timber more expensive. The Finno-Swedish lumber organisation largely controls the world prices of timber but this control is precarious as the U.S.S.R. could upset the balance if her vast northern territories of forest land were cut-over for export.

MINERAL WEALTH

Mineral deposits are not extensive. Copper pyrites has been worked for some years at Outokumpu; the ore body, regarded as the largest copperfield in Europe, is estimated to contain 17½ million tons with 4 per cent copper, and about 25 per cent each of iron and sulphur. The Outokumpu ore mass is two miles (3½ km.) long, about 900 ft. (275 m.) wide and 23–33 ft. (7–10 m.) thick. By 1946 there had been extracted 6·2 million tons of ore which contained, besides copper, iron and sulphur, compounds of zinc, cobalt, nickel, gold and silver. At the concentration plant, established in 1928, using the flotation process, 0·6 million tons of ore are annually treated giving concentrates of 20 per cent copper, 40 per cent iron and 45 per cent sulphur. By the electrolytic process some 24,000 tons of copper are produced annually and from roasted pyrites 60,000 tons of iron and 104,000 tons of sulphur; the Harjavalta smelter and Pori refinery are both located on the Ostrobothnian plain. From the Nivala ore about 800 tons of nickel are obtained each year and this, as with the copper output, exceeds home needs, but the production of sulphur is only just adequate for the requirements of the sulphuric acid and cellulose industries. During the treatment of the ores about 660 lb. of gold and 13,200 lb. of silver are obtained, and this supplemented the supply of alluvial gold which was obtained from river gravels at Ivalo. To deal with the iron there is nearby an ironworks with a rolling mill. Larger deposits of iron-ore, a magnetite-ilmenite, are found at Otanmäki in the Lake Region where the 50-million-ton ore-body contains 33 per cent iron, 7 per cent titanium and ¼ per cent vanadium. In Lapland at Porkonen-Pahtavaara there is a large deposit of low-grade iron ore while at Juvakaisenmaa, near the Swedish frontier, is another one, of higher grade, but neither deposit is likely to be worked owing to isolation from transport routes and power supplies. North of Outokumpu molybdenum ore is mined at Mätäsvaara although it contains only 0·2 per cent of molybdenite. Formerly, nickel was also obtained

from Kolosjoki in the Petsamontunturit district, where a subsidiary of the Mond Nickel Co. commenced operations in 1938–9. Although the nickel content is under 2 per cent, together with 1 per cent copper, the deposits of ore (some 4 million tons) are the greatest in Europe; they were worked by an adit 2 miles (3½ km.) long. The mine, however, is now in Russian hands.

The demand for limestone and dolomite is met by quarries and mines in the south; some of the output is used for cement production. Granite of a variety of colours—red, grey and black—is produced, and exported for monumental purposes.[1] Other non-metallic minerals exploited are asbestos, worked at Paakkila and Maljasalmi, for a factory near Helsinki, and graphite quarried at Kärpälä.

HYDRO-ELECTRICITY

The exploitation of the mineral and timber wealth of Finland has been aided by the use of some of the huge potential of hydro-electric power. Originally the presence of the rapids, which rarely exceed 65 ft. (20 m.) in height, was regarded as a handicap, for they interfered with navigation, but they are now realised to be of inestimable value. The ability of Finland to borrow the capital required permitted the establishment of power stations, and the inter-war years

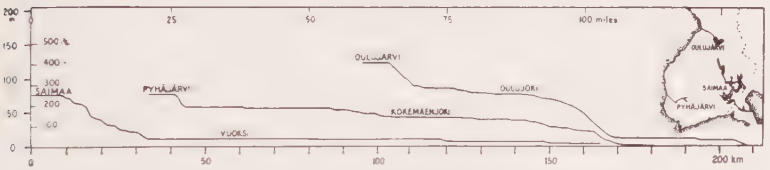


FIG. 42.—RIVER PROFILES IN FINLAND.

Longitudinal profiles of three rivers, located to the right of the diagram, showing the rapid descent from the plateau edge and the consequent opportunity for power development. The vertical exaggeration is ×200.

Based, by permission, on *Atlas of Finland*, 1925, Plates 12–14.

saw the trebling of the installed power plant to 962,000 h.p. out of a potential of 2,300,000 h.p., while the electricity generated was increased twenty-five fold. From the Imatra Falls a power plant completed in 1929 supplied power over southern Finland until it was seized by the Russians. It is intended to construct hydro-electric stations in the north and to distribute the current to the south. The great number of lakes means that the water is very clear, for the sediment has been precipitated, and deltas are forming only at the mouths of the Lapland rivers. In central and southern Finland the

[1] Until 1953 these granites, polished in Aberdeen, were sold under trade descriptions such as Balmoral Red, Braemar Grey and Glencoe Grey.

flow varies little throughout the year, whereas in northern Finland the rivers, lacking such lakes to regulate their flow, have a tremendous fluctuation, with floods at the melt period of early summer. Most of the Finnish industries depend on hydro-electric power, and it has allowed the establishment of calcium carbide, nitrogen fixation, and other chemical works. However, the supply of hydro-electric power has been insufficient to meet their demands, and industrial needs were mainly responsible for the pre-war increase of annual coal imports to $1\frac{1}{2}$ million tons.

FISHERIES

The fishing wealth is varied but not rich, owing to the brackish nature of the northern gulfs of the Baltic Sea. The most important species caught here is the Baltic herring (the Swedish strömming) but salmon, muikku (*Coregonus albula*) and pike are also taken offshore and in the lakes and rivers. By using depot ships, Finnish vessels catch herring off Iceland, while before 1939 the Arctic cod fisheries provided the basis for a cod-liver oil industry at Liinahamari.

INDUSTRIES

Nearly half the raw materials of industry are drawn from domestic sources and this is a source of strength to the growing Finnish industry. Hitherto the rival demands of land for agriculture and forestry have led to strife between opposing factions, but the present shortage of suitable land, and the need to co-ordinate different demands is likely to result in better planning of land use. The difficulty of industrialisation in this northern region caused the State to participate in industrial activities from the early days of the republic and now the State owns most of the share capital in Enso Gutzeit Oy (pulp mills, sawmills, etc.), Imatran Voima Oy (power station), Outokumpu Oy (copper mine and works), Veitsiluoto Oy (saw and pulp mills), Rikkihappoja superfosfaatitehtaat Oy (sulphuric acid and superphosphate works), and in the State liquor monopoly. Up to the outbreak of war such State activities—some of which have passed to the Soviet Union—provided a valuable revenue:

State Revenue, in million marks, from Business Enterprises, 1937 *and* 1960

	1937	*1960*
State Railways	248	34,455
Interest and dividends	246	19,462
Forest service	186	14,617
Posts and telegraphs	69	19,974
Share profits, Bank of Finland	50	824
Landed property	12	658

COMMUNICATIONS

Communications have greatly improved during the twentieth century. The waterways, comprising about 8,700 miles (14,000 km.) of maintained floating channels, are efficient and their use is encouraged by the many bogs which cannot be crossed by rail or road without expensive stripping and drainage. The natural waterways have been improved by canalisation; an example is the Saimaa Canal, completed in 1856 along the line of a former course of the Vuoksi river, by which the sea was connected with a network of lakes, and permitted ship connection from Viipuri (Viborg) to Kuopio, over two degrees of latitude (160 miles, 256 km.) distant from the Gulf of Leningrad. These waterways have numerous lakes to regulate the water flow, and are aligned towards the south, south-west and west, so that they thaw in the right order, from the mouth towards the headstreams. Unfortunately, the excellent system was disrupted when the frontier was moved after the war, and connection was severed between the most important waterway-network and the Gulf of Finland. With the consequent higher transport costs due to using road and rail, this has had serious repercussions upon Finland's ability to supply lumber and timber products cheaply.

The railways were constructed on the "broad gauge" of Russia and the pattern was a response to Russian strategic needs, so that between the wars many new links had to be provided and Finland now possesses a closer network per head of population than any other European country except Sweden. One desirable link—from Liinahamari to the south—has so far proved too great a project for Finnish resources of manpower and capital. Before dieselisation expensive coal was only used on a few express trains where wood refuelling, which took fifteen minutes for every two hours' run, wasted too much time. Already the railways play a fundamental part in the well-being of industry and trade, including the butter export. One reason for the large proportion of the traffic which moves by rail is the limited road network and the closing of lake navigation at the formation and thawing of the ice in winter.

Roads were also originally laid out to suit Russian needs and so are found in the coastal zones. The suitability of the frozen lakes for transit in winter, very much better than a man-made surface as it is not liable to snow-blocking, has discouraged the sinking of capital in roads. Soon after the acquisition of the Arctic seaboard, a road was constructed from Rovaniemi to Petsamovuoma (Petsamo fjord); it was found that the road could be kept open in winter for wheeled vehicles only as far as Sodankylä and that sledges, which took up to ten days for the 230 miles (370 km.) had to be used north

over the water-parting to Liinahamari. Away from the navigable waterways however it has been necessary to improve roads and two roads now cross the frontier into Norway: it is expected, too, that modern roads will stimulate tourism.

Seafaring is essential to Finland, and when wooden ships were common there was a considerable ship-building industry which is now but a shadow of its former grandeur. The merchant fleet tonnage per head of population was only below that of the other northern countries and Greece, and although losses by war and reparations reduced the 1947 tonnage to under one-third of that of 1938, the former total has now been more than regained. About twenty first-class ports exist and there is no undue concentration upon any one, for although Helsinki (Helsingfors) takes 40 per cent of the imports it only handles about 12 per cent of the exports. By ice-breakers it is possible to keep Hanko (Hangö) open in winter, and for a time before the U.S.S.R. absorbed the eastern Baltic States, it was hoped to attract a transit trade in winter between the Soviet Republics and the outer world. The approaches to Hanko (Hangö) were, however, not so easy in winter as to deter the Finns from desiring to develop Liinahamari on the ice-free Arctic shore.

Transport of Finland

	Railways		*Merchant Fleet*
	route-miles	*route-km.*	'000 *net tons*
1920	2,660	4,280	484
1925	2,995	4,820	488
1930	3,343	5,380	510
1937	3,672	5,910	544
1947	2,913	4,687	187
1957	3,165	5,256	755 (G.R.T.)
1961	3,340	5,387	864 (G.R.T.)

COMMERCE

For centuries the commerce of Finland was controlled by other nations: she was under Swedish rule from 1154 to 1809 (during part of which period the Hanse League spread its activities to Finland) and under Russian rule from then until 1917, so that there has been only one generation of independence, when the fish, timber and butter traffic were not forced to go through other trading centres. When Finland severed her connection with Russia in December 1917 she was in a precarious economic position: her currency was depreciated

and her trade channels were destroyed.[1] The First World War eliminated the Russian market and so new markets had to be found. It was fortunate that there had been long-standing trade connections for selling sawn timber, paper and butter to western and central Europe. In 1912 sawn timber provided 43 per cent (by value) of the total exports, unmanufactured timber 10 per cent, paper and pulp 18 per cent, and butter 9 per cent. At this time imports for home consumption represented 60 per cent of the import traffic, especially coffee, sugar and tobacco, and imports exceeded exports. Twenty years later, the exports exceeded the imports and the total trade had more than doubled. The imports were no longer basically consumption goods, capital goods, such as equipment for power stations, having become more important.

The period of freedom was marred by the heavy debts inherited from the Russian régime, but after inflation came stabilisation of the mark at one-sixth of its former value, which reduced the debt burden. With the post-war demand for timber products the years 1922–8 were boom-years. In 1928, when the depression started, 83 per cent of Finland's exports were timber and timber products, compared with 55 per cent for Sweden, and so the economy was severely hit by the slump in timber prices. Unfortunately, this coincided with a failure of the harvest and a rise in rates of interest. In the economic slump Finland, deeply involved as a primary producer, followed Britain and the Scandinavian countries off the gold standard in 1931, and the mark was stabilised in 1932 at 227 to £1. Unemployment was rife, and many schemes of land reclamation and construction of improved communications were then undertaken in order to alleviate distress. Recovery was aided by a bilateral trade agreement with Britain, whereas the Germans now reduced their purchases of Finnish goods. This helped to turn trade away from Germany so that before 1939 the trade links with Britain were firmly forged; yet cultural links still remained closest with Germany. These years of recovery, which were years of favourable trade balance, wiped out the loans from abroad and brought in fresh capital for new development.[2] The recovery from the depression was also marked by a change in emphasis, away from sawmill products, which by 1935 had been reduced to 43·5 per cent of the total exports; this was an index that Finland was turning from being a supplier of raw materials to one of manufactures such as furniture, paper, cellulose and plywood. During the inter-war years it is

[1] Much of the trade classed as Russian before 1914 appeared as Estonian, Latvian, Lithuanian, Polish and Finnish between the two world wars.

[2] Finland was the only nation to pay in full her financial obligations to the U.S.A.

calculated that for 1924–38 the increase in production averaged annually 5·3 per cent for Finland, which compared favourably with 5·1 per cent for Sweden, and 3·1 per cent for Great Britain.

The wars with Russia in 1939–40 and 1941–4 blocked yet again the trade channels, and in addition created the problem of reparations. Under the peace treaty the U.S.S.R. demanded:

Wood products	100	million dollars (1938 U.S.A. values)
Shipping: old tonnage	14	„ „
Cable products	25	„ „
Machinery	101	„ „

Certain concessions were later given over the payment of reparations. The loss of territory to the U.S.S.R. aggravated the position, for about one-tenth of the country's industrial capacity lay within the ceded area, but even this does not give a full view of the severity of the blow, for in the ceded area were the only factory producing artificial fibres, one of the two sugar factories and one-third of the potato-flour and starch mills. Re-equipment of industry has been aided by Marshall Aid from the United States but the fear has been expressed that now reparations have ceased there may be difficulty in finding a market for the large, new capacity of industrial output. There was also a tremendous loss of man-power. The number of people who lost their lives in the wars with the U.S.S.R. during 1939–44 was about 78,000, i.e. 2 per cent of the total population. On the other hand, most of the damage to dwellings occurred in the area ceded to the Soviet Union, and, unexpectedly, the area of forest lost by fires was less than in some years of peace. By contrast, the brief war with Germany in 1944–5 was waged in the north and the damage was enormous, for the retreating Germans destroyed bridges, telephones and houses, and some towns, such as Rovaniemi, were devastated.

The re-settlement of displaced persons is another heavy burden. Some 424,500 displaced persons[1] (about the same as the total population of Finland in 1749) migrated from the area ceded to the Soviet Union into Finland, and to settle these folk, 1,175,000 acres (470,000 ha.) of fresh farm-land must be reclaimed. This is a long and difficult task even with the use of mechanised equipment.

REGIONAL GEOGRAPHY

Finland and the adjacent territory will be considered in the following regional order:

[1] 406,000 of these came from the eastern marchlands, and 18,500 from the ceded territory in the north and the leased area of the Porkkala peninsula.

The Coastlands (including the Åland Islands)
The Lake Plateau
Northern Finland
The Eastern Marchlands

THE COASTLANDS

From Tornio (Torneå) to Lake Ladoga there extends a ribbon of lowland up to 62 miles (100 km.) wide which has a distinctive character resulting from its geomorphological and human story. Many islands and skerries skirt the shore, particularly in the south. In the south-west can be distinguished the surface of a peneplane which slopes from about 330 ft. (100 m.) to below sea-level. This ancient peneplane has been partly dissected by erosion. In the interior the intervening hollows are partially filled by clay, whereas in the seaward section sea channels interrupt the rocky remnants of the peneplane as the summit level dips to form skerries and reefs. With the progressive uplift of the land, as a result of isostatic adjustment, the glacial drift has been removed from the surface of the rocky knolls whilst in the lower stretches between the rock outcrops the sediments, resorted by marine action, provide opportunities for agriculture. This repeats the story of the Bothnian coastal zone of nearby Swedish Norrland. Along the Ostrobothnian coast, north of Vaasa (Vasa) the gentle emergence of the land has left in erstwhile bays a fringe of sands and clays which in general have a smooth surface but are being cut into by the rivers. Along some stretches of the coast are well-developed sand-dunes with a smooth coastline.

Not all this coastal ribbon is underlain by older igneous rocks; between Loviisa (Lovisa) and Viipuri (Viborg) there is an outcrop of younger granite which has steeper cliffs and rather more rugged hills; debris from this outcrop forms great pebble banks along the shore. In the Karelian isthmus the solid rocks, south of a line from Koiviso to Käkisalmi (Kexholm) are almost completely buried under a mantle of sandy quaternary material. Archæology shows that on the Ostrobothnian coastal lowlands the first incomers settled along the contemporary shoreline which was then anything up to 62 miles (100 km.) inland from the present waterfront. As the land rose and fresh alluvium was exposed ribbons of settlement extended downstream. The settlers, largely Swedish immigrants, reclaimed the boggy stretches for arable and pasture land, and the most recent trend has been to convert meadowland to arable. To-day the main settlements are at the river estuary ports which can maintain contact with the interior by the valleys. Unfortunately continuing uplift has made some old harbours useless: for example, the modern port of

Vaasa (Vasa) lies 6 miles (10 km.) west of the meadows which mark the original harbour site.

East of Turku (Åbo) extends the valuable sector of the coastal lowlands where relief, soils and climate, backed by the existence of hydro-electric sites have given the country a more productive character. In the west are the threefold Salpausselkä marginal morainic[1]

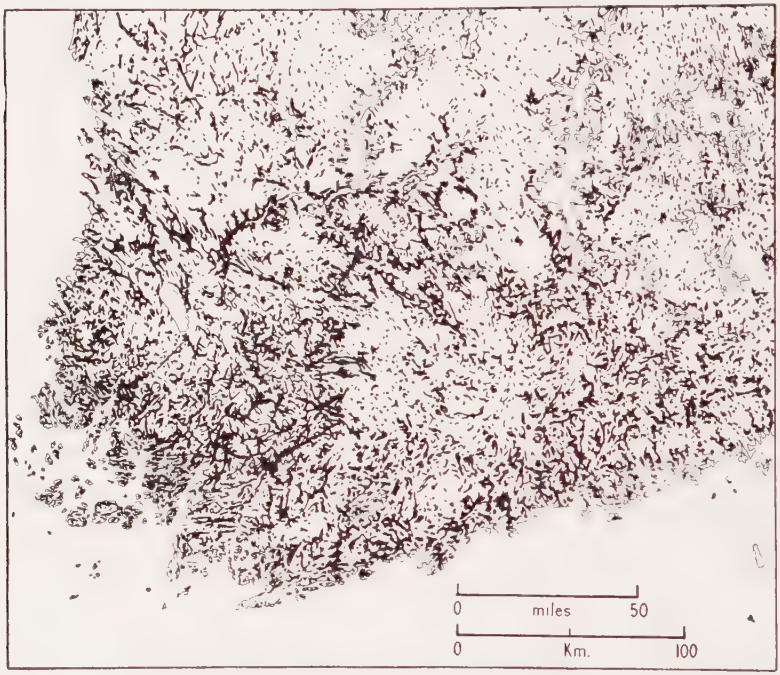


FIG. 43.—IMPROVED LAND IN SOUTH-WEST FINLAND.

The improved land, whether arable or grass, is shown in black for the most farmed area of Finland. Lakes are outlined but not shaded.

Based, by permission, on *Atlas of Finland*, 1925, Plates 15 and 16.

ridges, steep on the north and gently sloping southwards, which shelter the lowlands; the tree-clad embankment of the outer ridge is used by rail and road. The lowlands with their soils derived from clay and silt provide arable land which has in the west a longer growing season than the more continental east. Further, there is at Pargas the most important limestone deposit of Finland, which provides, by quarrying and mining, the basis of a cement industry.

[1] These ridges, formed of sands and gravels, are sometimes described as marginal eskers but in part have the character of a terminal moraine formed in a lake against a halted edge of the ice sheet. Some writers describe them as *oses*, which is an anglicised version of the Swedish word for esker.

Port development, in so far as it is influenced by traffic flow, has been greatly affected by the freezing of the inshore waters in winter. This is a considerable liability, for ice normally forms in the shallow waters along the shores of the Gulf of Bothnia in the second half of October and a fortnight later in the Gulf of Leningrad, and lasts until the end of April. During severe winters shipping used the ports of Turku (Åbo) and Hanko (Hangö) for these sites are nearest the main body of the Baltic and the ice is thinner and later in forming than elsewhere on the coast. By means of ice-breakers Kotka and Helsinki (Helsingfors) on the south coast round to Rauma (Raumo) and Mäntyluoto, the outport for Pori (Björneborg), and Kaskinen on the west have been kept accessible during most winters. On the ice along the Bothnian coast seals are caught in winter. 103809

The coastal lowlands contain most of the more important urban centres of Finland, and their significance can be seen in the way they have been used as pawns in political moves. *Turku* (*Åbo*) was the port for the easiest crossing to Stockholm, and the capital in the days of Swedish sovereignty; it now has shipyards which can construct ocean-going craft and has engineering workshops producing diesel engines. *Hanko* (*Hangö*), situated at the seaward extremity of the outer Salpausselkä ridge and at the entrance to the Gulf of Finland, was established as an outpost for Russia, and became in the days of control by the Finnish Republic one of the main centres for foreign trade which could be used by vessels drawing 30 ft. (9 m.). Unfortunately for Finland, this small but flourishing port was a desirable naval base and with the adjoining territory it was ceded to the U.S.S.R. but by the 1944 Treaty it was regained in exchange for the Porkkala peninsula. Although *Helsinki* (*Helsingfors*) was founded at the mouth of the Vantaanjoki in 1550 by Gustav Vasa it was only in 1817 that it was selected as the capital of Finland. Like most of the wooden built cities in the coniferous timber belt of northern Europe it has on more than one occasion been ravaged by fire. The principal port of Finland, it has a magnificent roadstead, and can accommodate alongside quays the largest vessels calling, but during average winters navigation is closed from the middle of February to the middle of April. Built on a promontory and with adjacent islands studded with bungalows for summer use, the capital has a charm of site enhanced by magnificent examples of modern architecture, intermingled with German and Byzantine buildings. The confined location has resulted in the construction of great blocks of flats and with the hard winters these ease the provision of water supply and central heating. With their acquisition of the Porkkala peninsula the Russians have effective military control of the Gulf of Finland and of Helsinki (Helsingfors) while, until a by-pass line was

constructed, all railway services between the west and the capital were also under Russian control. *Kotka*, founded only in 1879, alongside a mouth of Kymijoki (Kymmeneälv), handles nearly two-fifths of Finnish exports of forest products.

Further east, in southern Karelia, is the old town of *Viipuri* (*Viborg*) which grew up alongside an ancient Swedish fortress built to guard a water route to Lake Ladoga. Used by the Hanseatic League as a trading centre at a time when the site of Leningrad was still a marshy waste, Viipuri (Viborg) was rejuvenated with the opening of the Saimaa canal. This allowed timber to be floated from the eastern forest belt to the coast and, after Finland had gained her independence, all timber from this sector of the republic was shipped from here or from adjoining loading-places. The loss of this zone of the lowland to the U.S.S.R. has been a grievous blow to Finnish economy, because the timber now has to be taken by land routes to the west to be shipped from Hamina or Kotka. On Lake Ladoga is another ancient fortress site at Käkisalmi (Kexholm). Across the depression between these two fortified sites many migrations have flowed throughout the ages, and with the creation of St. Petersburg (Leningrad) the Russians dominated the area in their desire to protect one of the main entrances to their country. The recent acquisition by the Soviet Union of the Karelian lowland is but carrying on the tradition of the past: the former frontier lay only about 12 miles (19 km.) from Leningrad, so the desire of the Soviets to have it placed further to the north-west was understandable.

THE ÅLAND ISLANDS

The Åland Islands (Ahvenanmaa), lying only 75 miles (120 km.) from Stockholm, were, by a decision of the League of Nations in 1921, placed under the control of Finland, although the majority of the inhabitants are of Swedish extraction. While some of the scenery of the archipelago is due to the partial drowning of a tilted peneplaned surface, much is also due to the intrusion of newer granites. The complicated pattern is aligned along faults which are also responsible for the form of the great skerryguard between the Åland Islands and the south-west coast of Finland. Åland Island, the largest of the group, has considerable stretches of farm land. The population of the archipelago increased to a maximum in about 1880 but since then has slowly declined, although the proportion of arable land increased. Thus, in 1749, there were 8,993 persons; in 1815, 12,432; in 1880, 21,021; in 1910, 20,341 and in 1960, 20,921. With their quarries, fishing and shipping these islands are a valuable

asset to Finland. When cold weather with easterly winds prevails, that is with winter anticyclonic conditions, ice is heaped on the south coasts of the islands: only in very mild winters is sea traffic unhindered.

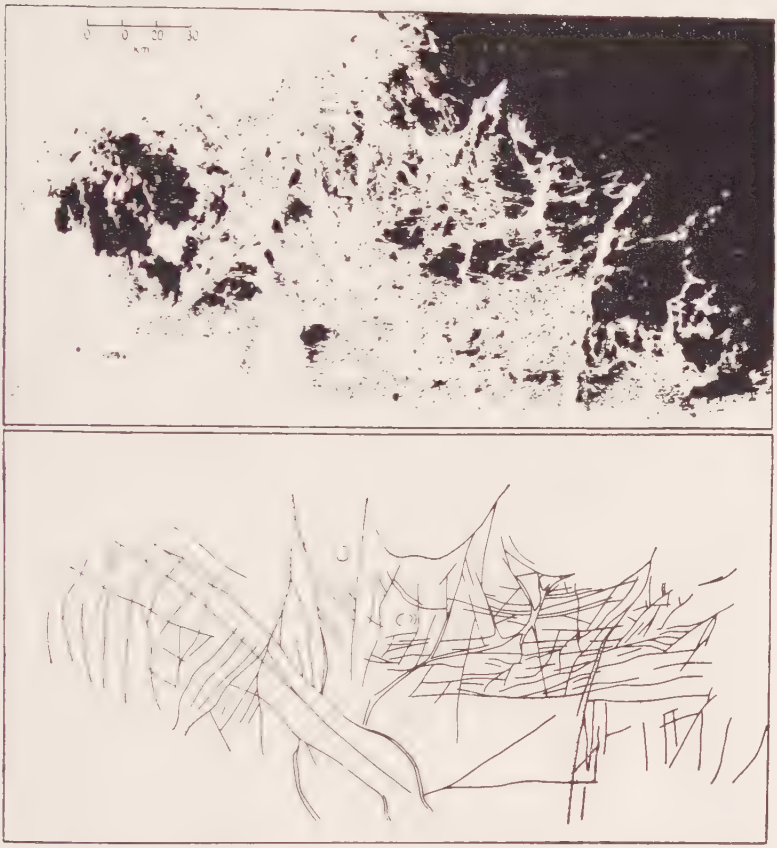


FIG. 44.—ISLANDS OF THE SOUTH-WEST.

Land surfaces in black in the upper diagram while the lower map indicates fracture and trend lines which have affected the land surface.

Based on H. Hausen, "Ytgestaltningen i Åbolands-Ålands Skärgård och dessorsaker", in *Skärgårdsboken*, Helsingfors, 1948, p. 50.

The principal settlement and port is Maarianhamina (Mariehamn) situated on the southern side. In this small but well sheltered harbour, suitable for vessels with a draught of up to about 20 ft. (6 m.), many ships seek refuge when ice interrupts their voyaging in the

Gulf of Bothnia. As a result of the activities of the late Captain Gustaf Erikson, Maarianhamina (Mariehamn) was the last home of square-rigged ships able to participate in the Australian grain-trade; Sweden still possesses barques for training seamen but these are not commercially operated. Unfortunately the Erikson fleet, composed of second-hand vessels, has been sadly thinned by time and even with

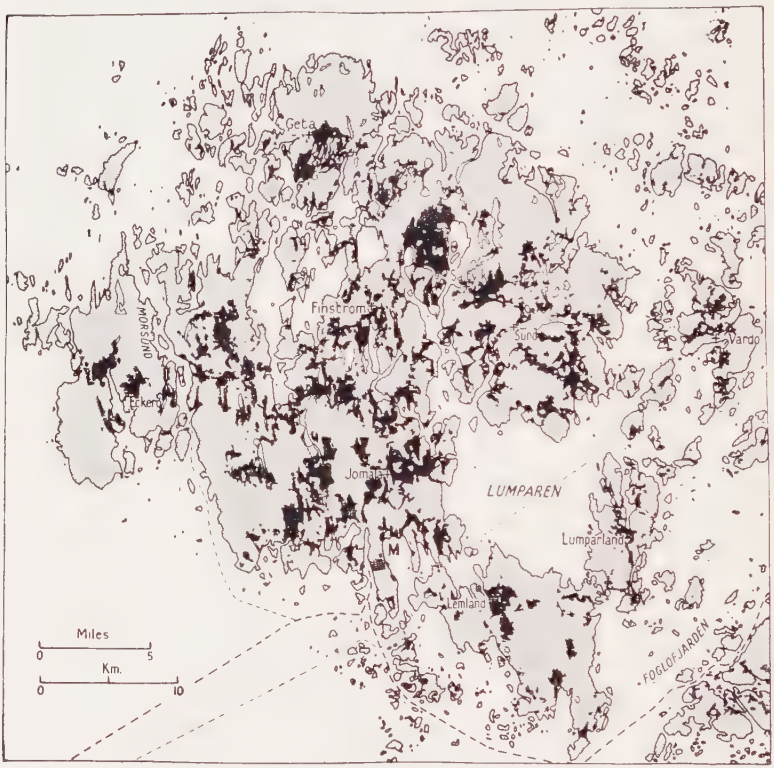


FIG. 45.—PART OF THE ÅLAND ISLANDS.

The intermixture of land and sea has given the Åland islanders their interest in the sea. Improved land is shown in black, main shipping channels by pecked lines and parish churches by a +. M = Mariehamn.

Based on German war maps of Finland (1:100,000).

crews reduced to the minimum it has been difficult, in view of rising costs of refitting and the removal of the sail-training stipulation for merchant officers, to make a commercial proposition of the fleet. Regular operations were interrupted in 1939, and the last Grain Race took place in 1949.

THE LAKE PLATEAU

From the main waterparting between the rivers draining to the Gulf of Bothnia and those draining to the Gulf of Leningrad there slopes gently a lake-studded plateau south and south-east to the curved ridges of the Salpausselkä. Carved into the granite and metamorphic rocks of this plateau surface are myriads of rock-basins, eroded by ice action and readily recognised from some 40,000 lakes. However, not all these lakes are set in rock-basins and many merely have morainic dams; some such dams have been trenched and the lake waters drained away for land reclamation. The pattern of the lakes coincides with the alignment of faults and the direction of ice movement and consequent dropping of ice-borne debris; frequently this is north-west to south-east.

Whilst this can be described as a plateau the surface is not horizontal, as can be seen from the elevations of the water surfaces; in the northern sector of the water courses draining to Lake Ladoga—which is only 14 ft. (4·3 m.) above sea-level—and to the Gulf of Finland the lake surfaces are at an elevation of 518 ft. (158 m. whereas in the south the elevation is about 230 ft. (70 m.). The southern zone of lakes is impounded by the great Salpausselkä ridges, the southernmost of which is within 30 miles (48 km.) of the coast; as lakes such as Saimaa have a surface 250 ft. (76 m.) above sea level the rivers draining the lakes are not graded and still have tumultuous rapids which, though obstacles to navigation, offer opportunities for power development. The greatest flow of water from the plateau is that of the Vuoksi flowing to Lake Ladoga (and therefore now in Soviet territory), the second greatest the Kymijoki (Kymmene älv) and the third the water which escapes westwards off the plateau by the Kokemäenjoki (Kumo älv). All three drainage basins, which include some power sites between lakes at different levels within the plateau, have at least one-quarter of the potential utilised.

Land utilisation within the Lake Plateau is dominated by the coniferous forests, both pine and spruce. The proportion of land under productive forests is the greatest of any region in Finland, whilst the proportion of waste land (rock outcrops and swamps) is the lowest, except for the southern sector of the coastal lowlands. Owing to clearing of land by fire and intensive lumbering the forests of this region are young. Rural settlement is mainly, although not exclusively, lakeside. Along the esker ridges, which are well drained and not so liable to frost, run routeways and lines of settlements. The area has suffered by the migration of many rural people who have gone to swell the numbers of the landless class in

the coastlands. Jackson[1] describes a typical farm of Central Finland with 20 acres (8 ha.) devoted to oats, rye, potatoes and fodder crops with 80 acres (33 ha.) of forest. The livestock, few in number, provide most of the food and clothing while a cash income is obtained by the man's working in a local factory. By reclaiming a little land from the birch forest each year fire-wood is also provided from the holding.

Towns within this region are either alongside old fortifications erected by the Swedish armies against the Russians or at modern

Photograph by courtesy of Finnish Embassy, London

FIG. 46.—MILLS AT TAMPERE (TAMMERFORS).

This town became industrialised on the basis of water power and early specialised in textiles.

routeway centres. Kuopio, at a focal point on the lakes which connect to the Saimaa, is a steamer centre and ships timber and granite bound for the coastal lowland. Much more important industrially is Tampere (Tammerfors), 100 miles (160 km.) north-north-west of Helsinki (Helsingfors), which has outpaced the old fortress town of Hämeenlinna (Tavastehus). Power, obtained from the Tammerkoski, is used to drive the mills which were first built here when Czar Alexander I permitted the importation of machinery and raw materials. A Scot, James Finlayson, opened in 1820 a large cotton mill, and from this beginning the town has become the largest

[1] Page 186 *et seq.*

textile centre of the Scandinavian countries. In addition, leather goods, paper, machinery and locomotives are also manufactured.

These urban centres are linked by the abundant waterways which reticulate the landscape; the more important of the watercourses have been adapted for passage of ships as well as for floating logs.

NORTHERN FINLAND

North of the Ostrobothnian coastlands and the Lake Plateau extends the highest area of Finland and the one which has been least developed. To the north-west runs the narrow ribbon of Finnish territory which, since 1826, has protruded between Norway and Sweden in the Muoniojoki valley. Here occurs the highest hill in Finland, Haltiatunturi, 4,344 ft. (1,324 m.) on the waterparting between Bothnian and Arctic Ocean drainage. Straddling the country from this enclave to Korvatunturi, 1,594 ft. (486 m.) is the boggy fjell country separating the north and south flowing drainage systems. The landscape of Northern Finland varies in type, some districts being dotted by lakes of which the most considerable is Inari, which drains by Pautsjoki (Pasvikelven) to Kirkenes in Norway.

Overlapping the waterparting is the northern limit of coniferous forest which here is of slow growth and not exploitable and is therefore under State ownership. Although the relief is not great the latitude is high and on the hills and arctic slopes the vegetation is of tundra type with reindeer moss and so this is a home of the Lapps. On the southern flank settlements occur in the river valleys, but these become rarer northwards and few exist north of the waterparting. The region is one of isolation. Water-power sites are abundant but without lakes the run-off is irregular and lacking an economic motive there is no justification for the construction of large dams. After 1920, when Finland acquired Petsamo[1] and the approach corridor, road links with Kemi, on the Bothnian coast, were improved, but ambitious plans for a railway serving it, without which the Arctic Coast could not fully function as an outpost, were halted at the present rail-head at Rovaniemi. As a result the villages such as Petsamo remained a collection of scattered, tumbledown huts. At the outbreak of war the port facilities at the head of Devkin Cove (known to the Finns as Liinahamari) only consisted of a pier 150 ft. (46 m.) long with 26 ft. (8 m.) of water alongside.

This region of Finland is in the zone of Lapp occupation (see p. 80). About 450 Lapps lived in the Petsamo region in 1926, and the movements of these nomadic people caused certain administrative

[1] The Russian name for this district was Pechenga.

difficulties as they crossed the various international frontiers following their reindeer herds. The Petsamo region was little occupied under Finnish control; in 1926 the population was 1,905, of whom about 1,000 were Finns and the rest Skolts (semi-nomadic Lapps), Karelians and Russians; in 1935 it was 3,226, of whom 2,000 were Finns, and in 1938 4,288. This recent increase must be attributed to the development of the mining industry, for this area contains the main nickel ore-field in Europe.

The territory was returned to Russia in 1944 and so, besides losing the mineral wealth of the region, Finland was again without a naturally ice-free port. She is therefore in a less advantageous position for winter trading and has to rely upon being able to keep Kotka, Hanko (Hangö), Turku (Åbo) and other ports open by ice-breakers.

THE EASTERN MARCHLANDS OF FINLAND

The territory to the east of Finland has a solid geology, a relief and a natural vegetation cover almost identical with Finnish terrain, whilst there have been certain human relationships which justify a brief space being devoted to territory beyond direct Scandinavian interests. For ease of treatment it will be considered in the two sections of Eastern Karelia and Kola Lapmark.

Eastern Karelia. Adjoining Finland is a counterpart with an intricate lake pattern (artificially simplified in older maps) and hills rising a few hundred feet above the general surface of about 650 ft. (200 m.). There is no mountain ridge separating Finland from her great neighbour. In the northern sector there is but a sparse population but farther south near Lakes Ladoga and Onega many of the lowlands have fertile soil which provides a basis for settlement and agriculture. Along the White Sea coast ice normally occurs from November to May but the spring tidal range is about $6\frac{1}{2}$ ft. (2 m.) which contrasts markedly with the Baltic coast. The rivers flowing across Karelia are also ungraded and the watercourses develop many rapids as they cross the gneissose granites characteristic of the Fenno-scandian Shield on which the territory lies.

At the Peace of Pähkinäsaari (Nöteborg) [1323] Karelia was divided between control from Sweden and Novgorod but acts of pillage and war were performed by both sides in the other's territory in order to enlarge their domain, and this state of affairs continued for three centuries until the Peace of Stolbova (1617), when the eastern boundary of Finland was fixed much as it was in 1920. On the east of the boundary came "Russification" with the spread of the influence of the Orthodox Church; on the west under Swedish influence the people adopted the Lutheran faith. The Karelian

people of this territory still retain words which are current in Finnish and some of these people, at any rate, came from the same stock in their migration north from Estonia. In the past many pedlars went in the winter from Karelia to Finland; the languages were sufficiently akin to make understanding easy, and this used to maintain the cultural connections and at the same time brought a cash income into the region. Along the coast, even in Czarist days, there were sawmills utilising the rivers for floating timber and power but the exploitation of the forest reserves has lagged behind that in Finland.

Near the coast of East Karelia runs the Murmansk Railway which was proposed in the 1870s. Construction of the northern section was suspended while the Trans-Siberian line was absorbing Russian resources and work did not commence until 1915. For the 654 miles (1,053 km.) north of Petrosavodsk, with the aid of American engineers and German and Austrian prisoners of war, construction was prosecuted so rapidly that the line was completed in 1916 to a terminus then called Romanov. If the area had not been under a different political régime from Finland it is probable that branches of this railway could have given an outlet by an ice-free port other than Petsamo. Under a reparations agreement the line from Kemijarvi was extended, *via* Salla, to the Murmansk Railway after the Treaty of 1940 and the economy of the north may be re-orientated with the opportunity of Russian exploitation north of the Arctic Circle.

Kola Lapmark. This may be taken as the whole of the Kola peninsula and the territory westwards to Norway. The frontier with Norway was delimited in 1826 when the *Faelles* ("Common") District was divided between Russia and Norway although Finland had certain unsatisfied claims.

Structurally this is part of Fenno-scandia and, although of higher altitude, has the same landscape of tundra and bog as is found in the Arctic slopes of Finland. Along the west of the Murman coast are found deep fjords but east of Kola Fjord (Kuollanpuono) the cliffs become lower and with sandy shores there are few sites for ports. Fortunately, a branch of the warm Atlantic Drift sweeps along the western sector of the Murman coast and keeps it ice-free whereas the White Sea, shallow and brackish, freezes most winters. The rivers have well-graded upper courses but, as a result of uplift, some 6 miles (20 km.) from the coast they have rapids and incised beds between precipitous sides.

Kola Lapmark is crossed by the northern limit of coniferous forest but growth is very slow: pines three centuries old are only 36 ft. (11 m.) tall and 12–16 in. (30–40 cm.) in diameter. There is a

general resemblance to the vegetation of northern Finland and Norway but the flora includes eastern species not found in the west.

As more vigorous stock entered from the south so the pacific Lapps were pushed north to the unfriendly shores of the Arctic Ocean. In addition to Russians there was an immigration of Finns and in the 1860s it appeared as if this was going to result in a Finnish colonisation of the Kola Lapmark, based on cod-fisheries and cattle rearing, but two decades later many of these Finns emigrated to America because the Russian government placed handicaps in the way of new settlements. That the Murman coast at one period appeared to have a strong Scandinavian element in the peopling may be gathered from the Table below.

Number of Families along the Murman Coast, 1899

	West Murman	*Kola Fjord*	*East Murman*
Finns	139	44	1
Norwegians	27	5	0
Karelians	54	1	21
Lapps	17	3	2
Russians	34	8	77
Other Nationalities	4	1	1

(Based on T. Homén, 1921, p. 31)

Another survey in 1918 showed in the West Murman and Kola Fjord districts the Finnish element as over half; farther east, of course, the Russians were dominant.

In 1917 Finland made a claim, founded on historical interests, to a share in the Arctic Coast. For a long period there was a common territory between Norway and Russia and later Swedish influence also penetrated to the area; gradually between 1595 and 1751 the ownership was resolved (see Figure 34). The Swedish rights were obscure but undoubtedly her nationals in Lapmark acquired fishing, sealing and grazing rights. When Finland passed to Russia in 1809 the Swedish rights were also transferred but these were ignored at the division of the Faelles District by Russia and Norway in 1826. Friction and distress resulted and in 1854 the Russian government gave the Lapps fishing rights on the Murman coast. During the succeeding decades, owing to continued distress, many Finns were migrating into the nearby Norwegian coastlands and in 1882–3 it was suggested that some territory should be ceded in exchange for the Systerbäck rifle factory which had been placed (after 1864) in Russian, instead of Finnish, territory. Unfortunately this was not agreed to by the Czarist government. After the Russian Revolution

Finland obtained a portion of the Fisher (Rybatchi) Peninsula (Kalastajasaarento) and the estuary of the Petsamonjoki together with an approach corridor, which cut across the headstreams of rivers draining into Kola Lapmark. This territory was ceded back to the Soviet after the war, the Fisher Peninsula (Kalastajasaarento) sector in 1940 and the rest in 1944. An area of indefinite physical features and few assets, it has figured unusually frequently in international agreements because it is a meeting zone for various nations. Another feature of this Murman Coast was the old-time *lingua franca*, the *Norskrusk*, which drew on words from the Norwegian, Russian and Lapp languages.

CHAPTER 7

SWEDEN—GENERAL VIEW

55°20′–69°04′ N.
10°58′–24°10′ E.

INTRODUCTION

Sweden forms the eastern portion of the Scandinavian peninsula and lies between Norway, the north of Finland (where the boundary follows the Torne älv and its main tributary, the Muonio älv) and the Gulf of Bothnia, while the southern shores are washed by the Baltic Sea, the Sound, the Kattegat and the Skagerrak. The greater part of the boundary with Norway runs along the negative region of the high watershed, but the southern section has repeatedly shifted in historic times, with consequent effects on the regions affected. The country is elongated, with a north–south axis of 1,000 miles (1,610 km.) and a breadth of some 250 miles (400 km.). Its area of 169,889 square miles (440,128 sq. km.) is nearly half as large again as that of the British Isles and 4·7 per cent of the total area of Europe.[1] The northerly location is appreciated if the 60° N. latitude line is followed on a globe; the line passes through the centre of Sweden, across the Shetland Islands, Cape Farewell in Greenland, north of Juneau in Alaska, across the neck of the Kamchatka peninsula and north of Tobolsk in Siberia. About three-twentieths of the area of Sweden is north of the Arctic Circle, but fortunately the climate is warmer than the latitude would suggest.

GEOLOGY

Most of the rocks of Sweden were formed in the oldest times of the geological history of the earth, namely in the Archæan, Algonkian and Lower Palæozoic periods. In general the Silurian strata are the youngest pre-Quaternary formation in the country, for only in Skåne are there outcrops of the three Mesozoic periods and some minor deposits of the Tertiary rocks.

The great mass of the Archæan rocks in Sweden may be divided into two groups—gneiss and granite. There is also a small "greenstone" (hypersthene-diabase) group which may be disregarded in its

[1] Compare with the State of California 158,297 sq. miles (409,989 sq. km.) population 10·6 million in 1950.

effect on the landscape as it only occupies a small area, but it is commercially important as the source of "black granite" for the monumental stone trade. The gneiss division includes granites which have been so altered by metamorphism that the structure of the original material is completely lost. The south-west gneiss district contains lenses of granite, of which only the margins have been metamorphosed, and the unaltered portions have been quarried round Varberg. The Södermanland gneiss district contains small workable deposits of magnetic iron ore. The granite group may be separated into porphyry and granite. The former, a fine-grained material, is derived from the extrusion of volcanic material in Archæan times through fissures which are associated with marine strata; the chief Swedish limestone deposits are in this group. Most of the Swedish ore-deposits also occur in association with the group of porphyries and leptites.[1] Of these by far the most important is iron. The Dannemora ores contain manganese while those of Lapland, chiefly magnetite with intermingled apatite, have a high percentage of phosphorus. The granite group is generally younger than the porphyry and is extremely variable, for the intrusions are of different ages. Following the formation of these granites there was an earth-storm and the rocks were intensely folded.

The rocks of the next era—Algonkian—are widespread in Sweden; they fall into two groups, the older chiefly of sandstone, with intercalated diabase beds as in Dalarna, the younger of sandstones, limestones, quartzites and crystalline schists, occurring in the fjäll regions. The older group was formed by the degradation of the Archæan rocks and so the basal beds are pebble conglomerates. The original area of formation was extensive but now the outcrops are confined to Dalarna (with an extension into Norway), Dalsland, and round Nässjön in Småland and round Storsjön in Gästrikland. The rocks vary tremendously; for example, those of Dalsland are thicker, more varied and more intricately folded than those of Dalarna. The younger group is the accumulated debris of an Archæan landmass lying to the east and south-east of the present outcrop.

The Lower Palæozoic rocks represent a period when most of Scandinavia was submerged with only isolated islands rising above the sea. Such a change represents a great subsidence after the Algonkian. Much of the preservation of these beds of shale, limestone and sandstone is due to the outpouring of igneous rocks which locally provided a resistant cap, for example at Kinnekulle. Elsewhere, as in Östergötland and Närke, the beds have been preserved by downfaulting which brought them below the level of erosion. The island of Gotland consists almost entirely of the

[1] Fine-grained crystalline schists of igneous origin.

younger beds of these Lower Palæozoic strata, and it is their high lime content which gives the island its character. These sediments have been much used for building, while the bituminous limestone is burnt for lime. The presence of limestones in this series provides the basis for a richer soil, and therefore a better agriculture, so that the outcrops of these rocks can frequently be recognised in detailed maps of agricultural distributions, although the great variation in the facies prevents a perfect correlation.

In the fjäll region, the Lower Palæozoic rocks, besides being much folded, are also metamorphosed to schist, for igneous activity continued here through Lower Palæozoic times. It was the resistance of these metamorphosed amphibolites with intruded granites which led to the formation, by differential erosion after uplift, of mountains such as Sarek, Sulitjelma and Kebnekajse. The folding force was such as not merely to crumple the rocks but also to form thrusts: along the eastern border the Archæan and Lower Palæozoic rocks were moved towards the east in a great overthrust which perhaps reaches a width of 80 miles (128 km.) in the west of Jämtland and in Härjedalen.

After the Lower Palæozoic period the whole of Sweden seems to have been dry land and this condition has continued ever since, except for local submergence in Skåne. Here also are found the oldest rocks after the Silurian, namely, Triassic clays and conglomerates resting unconformably upon Silurian rocks. Overlying the Trias are Rhætic-Liassic strata with thin intercalated seams of coal and clay-ironstone deposited upon a marshy shore. The Cretaceous deposits of Skåne are calcareous and vary lithologically from marl to limestone. In north-east Skåne these sediments rest on a bed of china clay beneath which is the much weathered Archæan mass. The preservation of these deposits results from the great faults of the Tertiary period which cross the province giving rise also to hills with a north-west to south-east trend. Near Malmö some "outcrops" of chalk have proved to be not of solid rock but great displaced masses imbedded in boulder clay. Of the Tertiary sediments there are but minor fragments in south-west Skåne although there exist eruptive rocks of this age such as the cluster of basalt bosses in Skåne, north of Ringsjön. The post-Silurian sediments outcrop over less than 1 per cent of the total area of Sweden yet their human significance is enormous.

During the Ice Age Sweden was completely submerged under the ice sheet which flowed from the north and pressed towards the North European Plain. The Quaternary sediments vary from morainic sands and gravels, with many erratic blocks, to clay. Where the moraine is derived from post-Archæan rocks it tends to be clayey

with a lime content and so provides a better soil for agriculture. At the close of the Ice Age, some 12,000 years ago, depression resulted in the formation of the Ancylus lake, which later connected with the ocean to form the Littorina sea, and deposits from these have now been exposed by isostatic uplift after the melting of the ice, with a considerable effect upon the land utilisation. To-day 287 small fragments of an ice cover, with an area of 127 sq. miles (329 sq. km.), remain in the fjäll upland.

RELIEF

The highest part of Sweden is the fjäll of the north-west which adjoins similar terrain in Norway. Below this alpine belt lies the zone of the Highlands of Northern Sweden consisting of a tilted plateau surface. Into the plateau large rivers have carved valleys which gradually open to the Bothnian coastal region where the landscape wears a very different appearance as it is mantled by sedimentary deposits of post-glacial age, except on the tops of knolls where the sea washed away the morainic deposits and re-exposed the country rock. Uplift of the land is still going on and the rivers are now cutting deeply into these marine deposits. The bare islands forming the skärgård of the Gulf of Bothnia and of Stockholm are the emerging tops of the hills of the future and as the land rises so the extent of the marine deposits between the bare hillocks increases.

South of these territories the lowlands of central Sweden extend right across the country in a wide belt: these lowlands do not appear as a continuous plain but as three large lowlands—Mälar-Hjälmar plain, Väner plain and Östgöta plain—which are separated by higher, stonier, forested lands. These plains, with included Archæan horsts are formed of Cambro-Silurian rocks preserved by faulting, as are the lowlands round Storsjön in Jämtland, and round Siljan in Dalarna. A striking feature of the lowland is the number of eskers which cross it in several directions, notably north-north-west–south-south-east; these ridges are often long and reach up to 200 ft. (60 m.) in height. They were valuable in providing early routeways and to-day are useful as a source of gravel.

The South Swedish Highlands represent the region which rose as an island above the post-glacial seas and form a barren, moraine-covered upland. At the margins of this upland lie the lowlands of South Sweden, including the islands of Öland and Gotland; they are formed by Cambro-Silurian rocks with, in Skåne, the addition of Cretaceous deposits overlain by post-glacial marine sediments.

Of the total surface of Sweden over 8 per cent consists of water in the form of lakes and rivers. Owing to the transformation wrought

by the Ice Age the river systems have acquired some of the characteristics of youth with immature longitudinal profiles, numerous waterfalls and rapids and a great profusion of lakes. Another effect of the geomorphological history is that many watersheds are indefinite

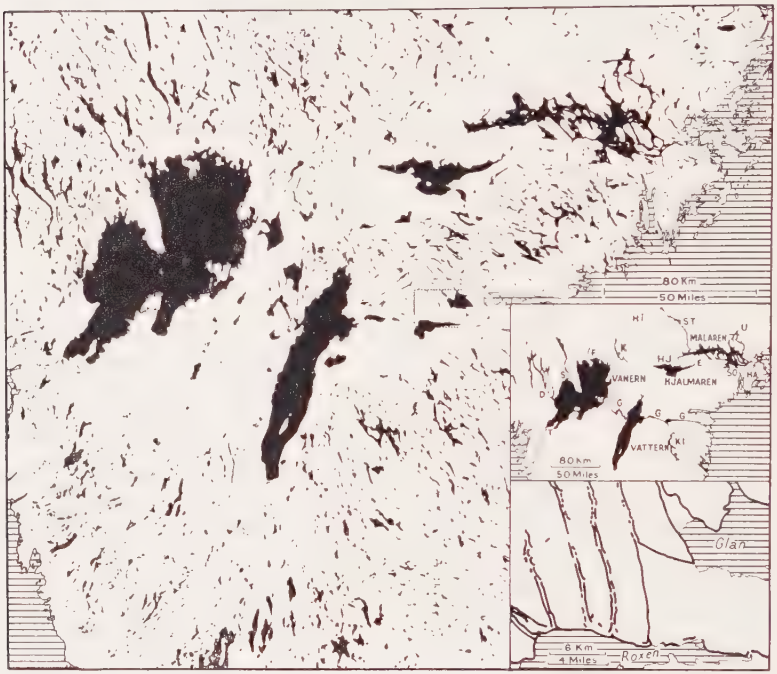


FIG. 47.—LAKE BELT OF CENTRAL SWEDEN.

Central Sweden is studded with lakes many of which owe their existence to fracture lines (lower inset). The presence of these lakes has facilitated the construction of canals the location of which is indicated in the upper inset. Canal names are indicated by initial letters:

D	Dalsland	HA	Hammarby	ST	Strömsholm
E	Eskilstuna	HJ	Hjälmar	SÖ	Södertälje
F	Forshaga and Karlstad	K	Knapfors	T	Trollhättan
G	Göta	KI	Kinda	U	Uppsala
H	Hörkens	S	Säffle		

Based on, for lakes, Sweden 1:500,000 (Höjdkarta) and (for faults) Sten de Geer "Explanation of map of landforms in the surroundings of the great Swedish lakes", *Sver. Geol. Unders.*, ser. Ba. No. 7, 1910, p. 20.

on the remnants of the uplifted peneplane surface. The prevalence of metamorphosed rocks and glacial clays results in little ground water, even if the soil is not frozen, and only in the limestone and sandy districts is there an appreciable underground reservoir to even the flow of the rivers. In the mountains of Sweden the snow cover

can remain for more than half the year, with consequently very low water in the rivers, while floods due to melting are very great. These floods usually reach their peak as first the lower, and then the higher snows melt. However, the lakes along the rivers of Norrland tend to even out the river floods. On the impermeable Archæan outcrops there are rock basin lakes as well as those formed by glacial deposits damming the narrow incised valleys. Central Sweden contains the greatest lakes of the country and these, the remnants of a still greater water cover, modify the climate and have had a far-reaching influence on development of the region.

The "Great Lakes" of Sweden

	Height above datum at mean water		*Area*		*Drainage area*		*Greatest depth*	
	feet	*metres*	*sq. miles*	*sq. km.*	*sq. miles*	*sq. km.*	*ft.*	*m.*
Mälar	1	0·35	440	1,144	8,160	22,386	210	63
Hjälmar	72	22	185	481			82	25
Roxen	109	33	37	96	5,173	13,350	26	8
Vätter	292	89	734	1,908	7,670	19,961	420	128
Väner	145	44	2,143	5,571	19,726	51,288	322	97

CLIMATE

As is well known, Sweden has higher temperatures than the latitude would suggest due to maritime influences, particularly the North Atlantic Drift and the prevailing westerly airstreams. Statistically this warmth is shown by the fact that the mean January temperature for Sweden is about 18 F. (10 C.) above the mean for the latitude, and that for July is about 6 F. (3 C.) above. The considerable latitudinal extension, with 15 per cent of the area north of the Arctic Circle, results in a contrast between northern and southern Sweden, a contrast accentuated by the high Scandinavian fjäll-lands, which prevent warm westerly winds entering the country and also by the difference of height between the north and south.[1]

The increasing shortness of the summer[2] northwards is partly compensated by:

(*a*) Comparatively higher temperatures in summer.

[1] The hardness of the winter frost in Norrland led to the construction of a crematorium at Kiruna. Elsewhere, as at Jukkasjärvi, the dead are kept in mortuaries until the thaw.

[2] In Sweden, summer is defined as the season when the mean temperature is above 50°F. (10°C.); winter as when it is below freezing point; spring and autumn are the intermediate periods.

(*b*) Greater length of day, e.g. at Karesuando the sun is never below the horizon for fifty-three 24-hour periods.
(*c*) Refraction, which increases the length of day by about 30 minutes in north Sweden and 15 minutes in the south (cf. 4 minutes at the equator), and lengthens the twilight.
(*d*) Infrequency of summer cloud.
(*e*) A considerable cloud cover in winter which reduces the loss of heat by radiation.

Some of these factors combine to give Jokkmokk for the month of June more hours of sunshine than either Rome or Madrid.

Precipitation is heaviest in the south-west and along the high frontier between Norrland and Norway. Over most of Sweden the principal maximum occurs in the later summer, sometimes with a secondary peak in October, while the minimum is in the early spring. With low temperatures there is a considerable snowfall which is not entirely a disadvantage. "All nature out of doors seems to be wrapped in a deep unwaking slumber. . . . The winter is, however, a busy season in the middle and north of Sweden for the forest-owner and farmer, and good sledging at this time is all important to the Swede who has any timber to get out of his forests or iron ore to transport from the mines. In a snowy winter the tops of the fences are scarcely apparent above the frozen snow. Gates are all thrown off their hinges; high roads are now little heeded, and short cuts are made across the country for sledging over the snow and frozen lakes as straight as the crow can fly."[1] The Swedish spring is short[2] and in Norrland indeed, is often only a long thaw. In Gotland alone are the spring and autumn long seasons as a result of the maritime influence of the Baltic Sea. The deeply incised valleys of the highlands of northern Sweden tend to become frost pockets on still summer nights when radiation encourages temperature inversion.

Secular climatic variations are revealed by bio-geological work as well as by actual records such as those of Tycho Brahe for the island of Ven, 1582–97; it appears that summers are now cooler and winters less cold than in the historic past.

SOILS

Soils in Sweden vary rapidly from locality to locality in response to the underlying material; for example, in Norrland the soils derived from post-glacial marine deposits are stone-free and easily

[1] Old Bushman (H. W. Wheelwright), *Ten Years in Sweden*, London, 1865, p. 114.

[2] An eighteenth-century French Ambassador to Sweden described the climate as nine months winter and the rest summer.

cultivated, whereas above the marine deposits the soils derived from glacial material contain many stones. Usually the soils are weakly developed, for all date from the post-glacial period and the cool, moist climate does not favour rapid soil formation; indeed in the coldest areas there is practically no soil development. While the ice-movement has carried the broken-down rock towards the lower land the character of the country rock is still reflected in the drift and so there is some relationship between the solid geology and the soils. The most important soil-producing strata are the Cambro-Silurian sandstones, shales and limestones which contain the elements for plant nutrition, particularly lime. As these rocks weather easily they tend to produce deeper soils. The Swedish Cambro-Silurian outcrop is part of a greater belt which extends across the Baltic to Estonia and Lake Ladoga and so similar soils are found on both sides of the Baltic. The rocks derived from Cretaceous limestone are as valuable as those derived from the Cambro-Silurian limestone. Apart from these outcrops, most Swedish soils require heavy liming and it is estimated that over one-half of the area of the country has such acidity that 65 tons of lime per square mile (1,632 quintals per ha.) are needed each year. In central and northern Sweden, where the cold snow-melt water deluges the ground at the thaw, efficient land-drains are required unless plant-growth is to be unduly retarded.

VEGETATION

The differences in climate, coupled with those in soils, create variety in the vegetation from moorland to deciduous woodland. On the fjäll above about 1,600 ft. (488 m.) there is a moorland vegetation of scanty and monotonous growth, poor in species and dominated by mosses and lichens, although there are dwarf forms of birch and juniper. Below this alpine zone is the birch forest zone characterised by *Betula odorata* with some aspen and rowan growth. Where the soil is moist and fertile the trees grow tall with a dense undergrowth, but usually there is rather a sparse cover. Lower down the slopes is the coniferous tree region which covers the greater part of the country and is dominated by Scots pine (*Pinus silvestris*) and common spruce (*Picea excelsa*). The southern part of this region is differentiated from the northern by the presence of the oak. Spruce, unlike most of the other plants, migrated into Sweden from Finland and, spreading southwards, has not yet completely covered Skåne. Outside this limit is a region of beech forest, associated with oaks, which has been largely cleared for agriculture. These tree belts are not continuous for locally there may be excessive moisture or too shallow soils.

PEOPLING

Because of the severity of the Ice Age, Sweden was peopled late (see Chapter 5). The immigrants came from the south and, as hunters and fishers, moved northwards, avoiding the inhospitable plateau of Småland, and occupying the central lake belt. As uplift exposed fertile alluvial deposits so the economy became agricultural and pastoral, although the climatic degradation which accompanied the Iron Age led to some migration across the Baltic with Gotland as a nodal point in the movements. The Swedish State was created in the central plains by the fusion of the Goth and Svea peoples, under

FIG. 48.— TUMULI AT GAMLA UPPSALA.

These tumuli, *circa* fifth century, are traditionally the burial place of the ancient kings of Uppland. The roof of the church which breaks the skyline has set against its southern wall the runic stone of Fig. 30.

the domination of the latter, and spread from the province of Uppland with its capital Gamla Uppsala. Barred from the west by difficult country these people, called *Rus* by the Finns, turned to the east and established centres round Lake Ladoga and on the Dnieper and gave their name to Russia. They also colonised the eastern shores of the Baltic and the Gulf of Bothnia. During the fourteenth and fifteenth centuries, Denmark was dominant and subjugated Sweden until the revolt of the Dalecarlian settlers and miners under Gustavus Vasa in 1521-3. During the period of subjugation there was intense colonisation within Sweden (marked by place-names terminating in *ryd*, *bo* and *saeter*), and a fusion of rival interests which paved the way for the period of Swedish grandeur in the seventeenth century. In this epoch of their history the Swedes

created a Baltic State which acted as a barrier to German advance. Although this golden age came eventually to a close it had lasting results, for it was then that Sweden acquired her foothold on the Skagerrak and the port of Göteborg was founded. This period also saw the creation and growth of the ports of Skåne which revealed the new orientation of the nation.

The Swedish nation has a remarkable homogeneity and the only important minorities are about 25,000 Finns in Norrbotten,[1] 10,000

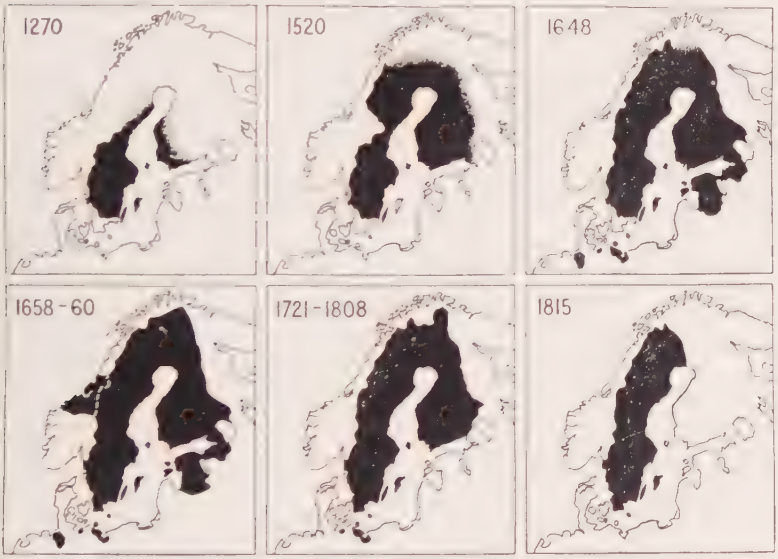


FIG. 49.—THE SWEDISH EMPIRE.

The gradual conquest of the northern fringe and expansion across the East Sea was followed by contraction in the eighteenth and nineteenth centuries to the present boundaries.

Lapps, 5,000 Jews and several thousand descendants of 300 Walloon craftsmen brought in during the seventeenth century. The Lapps, although not numerous, have attracted much attention. Originating in the east, they spread over northern Scandinavia and slowly migrated as far south as Dalarna in Sweden where they first obtained legal rights of pasture in 1881. While their primitive economy was originally based on reindeer herding, over half have now become fishermen or, with the aid of the State, farmers who keep reindeer as

[1] At the end of the sixteenth century the Swedish government encouraged Finnish immigration into Dalarna, Hälsingland and Medelpad in order to open up the wealth of the forests.

a subsidiary source of livelihood. The nomadic Lapps obtained the right to cross national frontiers freely, Russia recognised the arrangement as early as 1595, and Norway in 1613, and there have also been later treaties to ease international friction. Over half the Swedish Lapps live in Norrbotten, where is also found the Finnish minority but the latter are relatively recent immigrants and are confined to the area between the Torne älv and the frontier. In Vittangi, 46 miles (74 km.) inside Sweden, Finnish is the recognised language.

Sweden has a remarkably long record of population statistics and these illustrate the effect of the "positive checks" of Malthus; namely a tendency for births to exceed the means of sustenance with a consequent rise in the death rate, followed by a new increase of population to replace the previous thinning. The population, which was 2·35 millions in 1800, had increased to over 7·50 millions by 1960. With low birth and mortality rates the net increase is slight and even this has been reduced by a weakening stream of emigration, notably to the U.S.A. There has been a shortage of man-power and for a decade or more it has been suggested that Sweden should encourage immigrants to counterbalance the declining working population. Since 1930 Sweden has had a slight excess of immigration over emigration and this has increased since 1940.[1] Most of these people came from the East Baltic countries. Anxious to obtain further workpeople after the Second World War, Sweden agreed to receive 500 skilled workmen from northern Italy, 500 industrial and agricultural workers from Hungary and 500 Jews from Poland. There was a proposal that a joint Scandinavian labour market should be organised but post-war conditions leading to a general shortage have prevented this proposal from being implemented except that Sweden and Denmark have reciprocal arrangements for workers moving between the two countries.

There is a drift to the towns, and a tendency for the rural population to decline; in 1800 under 10 per cent lived in urban areas compared with 51 per cent in 1961. This urban growth strengthened after the abolition of the old guild corporations in 1846 and since then urbanisation has proceeded more rapidly than in western Europe. It is significant that the towns on the west coast possessed in 1800 15 per cent of the urban population but that since 1910 the proportion has been over 25 per cent. The rural population is dispersed across the country and only in Norrland, where conditions

[1] See H. Gille, "Recent Developments in Swedish Population Policy", *Population Studies*, II, 1948–9, pp. 171–4, for a discussion on immigration. Many refugees found shelter in Sweden during the Second World War. Most have now returned but there still remain a considerable number from the East Baltic Republics. In 1960 emigrants were 15,138 and immigrants 26,143.

most resemble those of Norway, is there more than a series of isolated settlements.

The climate demands that houses must be well built, heated in winter (often by wood-burning stoves) and with double windows to retain the heat within the building. Apart from the towns and in Skåne and Gotland most of the dwellings are of wood. In the south the farmhouses reveal Danish and German influence, being built in a long single storey with the farm buildings grouped round a courtyard. With industrialisation the traditional simple, but solid, style has been replaced by a more pretentious villa type. The ravages of war and fire have destroyed many old houses and led to "modernisation". Many of the towns have approached the character of *rus in urbe* and have an atmosphere of spaciousness. Round Stockholm over fifty villa suburbs have been created; the most notable are Saltsjöbaden and Djursholm, but to house the ever-increasing population much of the residential area of the capital consists of modern flats.

AGRICULTURE

Under one-eighth of the area of Sweden is classed as cultivated or pasture land. The traditional system of agriculture was well summarised by Molesworth writing in 1692:[1] "The Soil in Places capable of cultivating is tolerably fruitful, though seldom above half a foot deep: and therefore more easily plowed, as it frequently is by one Maid and an Ox, and is generally best where there is least of it, that is in the little Spaces between the Rocks; and frequently the barren land, enriched with the Ashes of Trees growing on the Places that are burnt, and the seed raked among the Ashes, produces a plentiful Crop without farther Cultivation. This Practice is so ancient, that their Writers derive the name of *Sweden* from a Word in their language that expresses it: but the Danger of destroying the Woods has of late occasioned some Laws to limit that Custom." Since the middle of the eighteenth century the State has earnestly sought to divide up the arable land to the best advantage for farm operation and this policy has led to a dispersal of farms similar to that in Denmark. In this century smallholdings have been encouraged round the largest towns. From 1800 to 1870 there was active reclamation and pioneering of the land so that the arable area trebled in this period, but the phase came to an end with the opening of the New World grain supply and a shortage of rural labour in Sweden. Although the proportion of people engaged in agriculture

[1] Robert, Viscount Molesworth, *An account of Denmark*, London, 4th Edition, 1738, p. 204.

has decreased with increasing industrialisation, the agricultural yields have become greater. This increase must be attributed to the technical improvements such as intensified rotations, reduction of fallow, diversification of farms, improved varieties of crops and of livestock. As in Denmark, when the price of cereals fell the country turned from grain selling to the production of dairy produce and the export of butter first exceeded the imports in about the year 1870. Having other sources of wealth, Sweden has not carried the development of the dairy industry to such an intensive degree as has her neighbour.

In the middle of the sixteenth century about 90 per cent of the working population was engaged in agriculture, which percentage decreased to 80 in 1750 and 70 in 1850, although the actual numbers engaged trebled. Since 1880 the actual, as well as the relative, numbers have decreased and now only one-third of the population is engaged in agriculture and its subsidiary industries. The bulk of the workers are on their own land, for four-fifths of the agricultural holdings are owner-occupied. A feature of the development of Sweden is the continued existence of a peasant-proprietorship and a free peasantry despite critical periods at the end of the Middle Ages and in the seventeenth century when strong aristocracies arose. The forested lands, little settled, offered small inducement to large-scale landholding and feudalism never became established in Sweden. After the Thirty Years' War there was an influx of foreign nobility, mostly of German origin, and to pay for the war the State sold lands and the right of taxation to these nobles but many of the land grants were cancelled at the end of the seventeenth century and any tendency towards feudalism was nullified. The introduction of new techniques was difficult because of the traditional conservatism of the dominant peasant class. Enclosures were practically unknown before the second half of the eighteenth century, and even the three-field system represented an advance found only in a few provinces. From ancient times labour had been obtained for the farms by a crofting system but gradually money replaced labour as the rental. In this century attempts have been made to create agricultural labourers' smallholdings with a view to retaining workers on the land.

Sweden can be divided into three main agricultural zones: the south, where fortunately the most favourable climate and soils coincide, produces wheat, sugar-beet and other crops, the central belt grows some cereals and root crops, while the north is a region of livestock rearing. The frost-free period averages 140 days in the south and decreases eastwards and northwards, but the average figures mean little because, with an accidented relief, there are many local frost-pockets. The shortness of the growing season is a

major handicap, but the evolution of frost-resistant and more rapidly maturing varieties has allowed crop cultivation to be pushed northwards. There is a certain latitudinal zonation of crops; potatoes grow farthest north, next six-row barley, then rye and oats. Wheat is grown nearly to the northern limit of the oak, that is to the southern edge of Norrland, but sugar-beet is more restricted. Where the precipitation is low, that is about 16 in. (400 mm.), bread cereals predominate but where it is heavier, and the soils are also less fertile, grass and oats become dominant.

Where temperatures are sufficiently high, precipitation is never great enough to prohibit farming. However, the maximum fall occurs in late summer and this hinders ripening and harvesting of crops. Only in the south-east and in Öland and Gotland are summer droughts a liability.

The land-use returns show that only 8·7 per cent of the land is classed as arable, 0·1 per cent as gardens and orchards, 2·6 per cent as grassland, 54·7 per cent as forest and 34·9 per cent as "other land". This includes the morainic moorlands (as in west and north Sweden), bogs and fens (as in the South Swedish Highlands), sand-dunes (as in the east of Skåne and Gotland) as well as bare rock, alpine fjäll and roads and buildings. With a varied physical background there are great differences within Sweden, the chief arable districts being in the lower, less hilly and good-soil country of the south. The climate affects crop growth in detail as well as generally, a frost-pocket for example repelling or a warm, southern aspect attracting the plough. The plain of Skåne-Halland is the most highly cultivated region of Sweden: about four-fifths is ploughed and there is little forest or grass cover. Permanent grass has decreased considerably during the last seventy years as almost all the increase in the arable area has come at the expense of the permanent grass; it was easier to convert this than to clear forests or remove boulders from virgin fields. Since 1866 the Swedish Moor Culture Association has promoted the cultivation of peat mosses. The size of the holdings varies regionally: in Norrland the average size of the arable holdings at 10 acres (4·2 ha.) is about one-third of those of the southern plains. Such an area would be insufficient to provide a living if it were not for the supplementary forest work and profits from owning woodlands.

In 1800 the growing of cereals alternated with bare fallow and farmers relied on natural hay for winter fodder. Nowadays there is a great dependence upon root crops to meet the needs of livestock. Wheat, particularly winter wheat, is grown mostly in Malmöhus province but its cultivation has spread into Central Sweden, except in sandy districts where it is replaced by winter rye. Winter wheat is

cultivated in northern Bergslag and in eastern Dalarna, although it is near its northern climatic limit and soils are meagre. Improvement of strains has nearly doubled the yield per acre since 1880. During the First World War more land was placed under spring wheat than previously because, with a high gluten content, it reduced the need to import "hard wheat" for milling. It is still grown in Skåne and the Östgöta plain. When it was regarded as of less value than winter wheat it was relegated to the poorer soils and yields were low but, as milling demands rose, better lands were used and the production about equalled home requirements. Winter rye used to be the principal winter cereal but it is now displaced by winter wheat, and only in the south-eastern foothills of Kristianstad is rye of significance, for here the soils are sandy and the slightness of the rainfall in spring and early summer injures wheat crops.

Barley in Sweden is grown exclusively from spring sowing, although both the two-rowed and six-rowed species are grown. The more exacting two-rowed variety is cultivated in Malmöhus, Öland and Gotland while the six-rowed is found chiefly in Norrland where it takes up one-tenth of the arable area. There has been a great decrease in the acreage, since barley has tended to be replaced by oats. Of the barley produced, three-fifths is used for fodder and the rest divided between malting and human consumption in the form of groats and bread. Since 1850 oats has become the most widespread cereal and was a major export in the period 1870–1900. The centre of production is in the coastal plains of western Sweden and round Vänern particularly in the province of Skaraborg. In northern Sweden the quicker maturing six-rowed barley is grown and the oats cultivated are used for green fodder.

Potatoes are widely cultivated and only in the interior of Norrland, where the frost risk is considerable, is there much purchasing from other parts of Sweden to meet farm needs. The yield per acre is greatest in Norrland, probably because only the poorest lands of the south are placed under potatoes. The very poor sandy soils of the south Swedish foothills are used for potatoes and supply the factories making schnapps and starch. Other centres of potato growing are round the towns for local consumption. It is estimated that about half the potato crop is used for fodder, two-fifths for human consumption and the rest for seed potatoes and the manufacture of starch and schnapps. Of the Swedish crops sugar-beet is one of the most limited in distribution on account of its exacting requirements of soil and labour. Although the production only became significant from the 1880s Sweden is now practically self-supporting in sugar. An incentive to its cultivation is the value of its by-products to farmers as fodder.

Although the long winters necessitate indoor feeding (from the end of October to the middle of May in Central Sweden) pastoral farming flourishes; the climate favours fodder production, while the small irregular stony fields discourage cropping. Before adequate winter fodder supplies were available October figured in the Swedish almanacs as *Slakt månad* (slaughtering month). When Sweden turned to livestock farming, since the 1870s, the number of all animals, except sheep and goats which are destructive of forests, have greatly increased. The major change has occurred with pigs, but numbers alone do not provide a complete view, for the animals themselves are more valuable. Estimates suggest that the value of the livestock sold off the farms is now fourfold the crop value.

Cattle are kept mainly for milk production and the chief breeds are the Swedish Red-and-White, Swedish Friesian, North Swedish Polled and Swedish Red-Polled. The last two are indigenous breeds, while the Red-and-White has an imported Ayrshire and Shorthorn strain and the Swedish Friesian are derived from the marshlands of north Germany and the Netherlands. The improvement of the breeds has been aided by the State which has encouraged careful milk recording. From these records it is found that the Friesian produces most milk, but with least fat content, while the smaller, but hardier, North Swedish Polled cow, only found in Norrland, produces least volume of milk at a lactation but has the highest butter fat content of the four chief breeds. Of course, as cattle cannot be out during winter a strawed open courtyard well filled with store cattle is never seen. Sheep tend to be limited to fenced pastures in the woodland districts where they improve the grazing; the main exceptions to this location are the sheep flocks of the rough grazing of Öland, Gotland and the west coast. Efforts were made in the eighteenth century to introduce a merino strain, but failed because the mutton quality was reduced. The majority of the sheep kept in north Sweden are the Swedish Improved Landrace, on Gotland the Gotland breed, in Skåne Oxford Downs and Shropshires, with Cheviots elsewhere.

The numbers of pigs have increased rapidly, with the greatest concentration in Skåne and a decreasing density northwards. Besides the ubiquitous "household" pig using kitchen waste, there is large-scale production, using skimmed milk, potatoes and fodder cereals supplemented by imported maize for fattening. This has encouraged commercial pig keeping in the districts best suited both for local production of feeding stuffs and for the import of maize and the export of bacon: that is in the district bordering the Sound. Quality has been raised by concentrating upon Large White and Improved Swedish Landrace.

Only since 1924 has the keeping of furred animals become an

established industry, but now large numbers of silver and blue foxes, mink and swamp beavers are bred for their skins. Reindeer are the traditional livestock for the utilisation of the Norrland pastures and the numbers rose from about 110,000 in 1855 to 235,000 in 1925, and to 275,000 in 1960. The reindeer need to roam

FIG. 50.—LAPP GRAZING DISTRICTS.

The Lapp rights extend parallel with the river valleys and overlap, in places, the political frontier with Norway. Special privileges were granted to allow the Lapps to follow their herds.

Based on E. Bergström, *Karta över renskötselns utbredning i Sverige*, Stockholm, 1923.

widely to graze and so cause friction with the Swedish settlers. They are rounded up in ring fences some 80 ft. (24 m.) in diameter, but primitive methods of herding are now vanishing as the Lapps, who are often wealthy, adopt modern devices, such as motor-bicycles, to visit the herds. The reindeer are killed for their hides

and the flesh either sold or kept for home consumption in winter after being preserved by drying or smoking. There are two main kinds of reindeer herds: the mountain reindeer which live in the mountains in the summer, where they obtain fodder and immunity from mosquitoes and gadflies, and the much smaller numbers of forest reindeer which do not migrate and are principally owned by peasants.

The advance of agriculture has been aided by the development of the co-operative movement which has created dairies, egg-packing stations and slaughterhouses and has thus reduced costs. The co-operative organisations have also provided technical education and credit facilities.

FORESTRY

The exploitation of the forest wealth plays a big part in the economy of Sweden—whether for charcoal, sawn timber or pulp production. Sweden is richer in forests than is Norway and each year there is an annual growth increment of 2,410 million cubic feet (68½ million cu. m.). The principal commercial trees are *Pinus sylvestris*, *Picea excelsa* and *P. obovata* with their stout trunks, few branches, fine grain and abundant resin. The roots of the pine penetrate deeper than those of the fir, but the pine does not require such a rich soil and can flourish on dry sandy areas. However, the fir stands can be closer and the trees mature more rapidly. In Värmland pines are not fully grown until 180 years old, in Dalarna 210 years and in Norrland 300 years. Forestry and agriculture are interdependent in the rural economy and everywhere, except in the most fertile plains, forest work is done in the slack winter of the agriculturalist and provides him with a much needed supplementary income. By creation of small holdings, forests have been supplied with settled workers and casual labour deals with the seasonal peak demands.

With poor communications, the use of charcoal for smelting[1] was an easier use of the timber wealth than preparing deals and balks, even though the Hanseatic cities, the Netherlands and England in succession imported quantities of timber for ship construction, harbour works and general needs, up to the time of the Napoleonic wars. Norway, whose iron industry was unimportant could better supply Britain with timber than could Sweden with her keen interest in iron smelting. As smelting by charcoal declined,[2] so the system

[1] In 1854 it was estimated that about 6 million acres (2·4 million ha.) of forest was worked over each year for charcoal production. But "worked over" does not mean clear felling or even selective felling; the trees were topped and lopped for charcoal timber.

[2] Charcoal is produced in open heaps or in kilns: the latter method conserves tar, turpentine, wood spirit and acetic acid.

of reserving forests disappeared; the great northern forests passed into the hands of unscrupulous owners—some of them Scots, Germans and Norwegians—by purchase from the peasant-proprietors, who placed little value on them, and became exploited for timber. By the 1860s it was possible to write: "The axe has done its work too effectually; and rotten stumps, in many places four feet high, are all that now mark the spot where the giants of the forest once stood. It is rare to see a tree, at least in any ordinary forest within reach of a large river, above fifty years old."[1] This ruthless use of the forest wealth was rampant from 1850 when Free Trade opened the British

A.C.O.] [*July, 1932*

FIG. 51.—TIMBER SORTING PENS.

Such timber sorting points occur on the Norrland rivers where they are crossed by the railway from Bräcke to Boden as well as at the mouth.

market, which had been closed since 1809 by heavy duties in favour of Canadian timber. The many south-east flowing rivers were improved for floating logs down to steam-driven sawmills on the coast. Without the "floatable" rivers vast stretches of forest in Norrland could not be exploited economically. The logs, released after the main spring flood, "dance" down the rivers, a watch being kept at rapids to avoid jamming: logs which catch are moved on into the mainstream by loggers working from rafts and so well is the movement managed that less than one log in a hundred is lost in transit by snapping and lodging. The floating of the timber frees it

[1] Old Bushman, *op. cit.*, p. 33: this account is doubtless overdrawn.

from sap and resin and makes it less liable to "shake" and warp, but it is supposed to reduce its durability. Until the 1870s sawn timber was the chief product for sale but then, as sawn timber prices fell with American competition, there was added the manufacture of pulp, cellulose and joinery work. If the demand for timber had remained for beams and balks Sweden would have now become a negligible producer.

Paper was first made in Sweden in the sixteenth century but not until the establishment of the mechanical pulp process in 1850 and of the chemical pulp process in the 1870s could its manufacture develop significantly. These industries consume a great amount of timber—for example one ton of pulp requires 175 to 280 cu. ft. of timber—while great quantities of power must be available. The manufacture of paper grew from 12,000 tons in 1877 to 225,000 tons in 1907 and 1,813,000 tons, of which 1,298,000 tons were exported, in 1960. The growth of the pulp industries was advantageous, for the mechanical process could use timber too small for plank production while the sulphite process needed fir instead of the pine preferred by the older timber industries. In some districts two-fifths of the timber requirements of the sulphate plant comes from the sawmills. As fir and pine are usually mixed in Swedish forests it leads to better forest management. A by-product of the sulphite process is the production of wood spirit which is mainly methylated. Forestry industries have benefited considerably from the activity of Swedish inventors, for example, safety matches were invented by Lundström at Jönköping and this town, with nearby Tidaholm, has become the match centre of the world. The best wood for matches is aspen (*Populus tremula*) which Sweden produces but she needs to import most of the chemicals needed, namely, phosphorus, antimony, paraffin and sulphur.

METALLURGY

Mining and metallurgy are ancient occupations in Sweden and still maintain first rank among her activities. Originating from, and maintained by, the existence of rich and great ore bodies, the exploitation of the minerals has been favoured by the timber and water wealth of the country. It seems certain that the first Swedish metallurgy using native ores was iron manufacture using simple furnaces to smelt lake and bog ore. In the sixteenth century however, the demand for iron increased rapidly and, encouraged by warlike kings, Germans, Walloons and Flemings were brought into the land to nourish an industry essential for military expansion. A notable figure among these immigrants was Louis de Geer of Liège,

whose descendants have played a worthy part in the intellectual life of Sweden. He established the armament works of Finspång and the workshops of Dannemora, employing French-speaking Walloons. The Swedish "golden-age" was created on this basis, and the foundations were laid for later engineering supremacy.

When charcoal was essential for ferrous metallurgy Sweden dominated the world's supply, using at first bog-ore and then Bergslagen ore; she came near to attaining a monopoly and even as late as 1740 produced two-fifths of world output, including practically all the malleable iron available for trade. With the substitution of coke for charcoal and the invention of the puddling process for wrought iron in England the Swedish share in the manufacture of iron and steel fell from 31 per cent in 1800 to 8 per cent in 1820 and 1·3 per cent in 1900. The production thus declined relatively,[1] for although water-power was available it was not yet used as hydro-electricity for iron smelting and imported coal was too expensive. But to-day Sweden is still, for its size, one of the most important countries in iron and steel production and is unique among the countries virtually without coal in retaining an iron industry. In this century the value of the iron-ore export has, in most years, given a favourable balance of trade and has done much to meet the cost of importing expensive coal and coke.

Swedish iron-ores are divided into three groups for metallurgical purposes: quartz-ores, requiring flux for smelting; gangue ores smeltable without flux; and limestone-ores with excess lime and so suitable for mixing with quartz-ores. Hæmatite is, as a rule, in the first category and magnetite in the second two. Swedish ores are usually titanium free and their phosphorus content determines the process used for the conversion of the iron into steel.

Phosphorus content	*Process*
Under 0·01%	Acid Bessemer and Martin
0·01–0·06%	Lancashire (wrought)
Over 0·06%	Basic.

Lake and bog-ore, impure iron-oxide hydrates and carbonates, are still worked on a very small scale for cast-iron manufacture.[2] Since 1898 ore with too low an iron content has been concentrated and the resulting slime made into briquettes. By prior roasting of these ores and the use of charcoal a higher-grade pig iron, free from

[1] The output of Swedish iron and steel increased tenfold in the period 1820–45 but new techniques were advancing output elsewhere more rapidly.

[2] In 1950 17 tons of bog-ore were produced compared with 13,611,029 tons of rock-ore.

sulphur, was produced than by coke furnaces; but this process is no longer used.

There are certain natural features which favour the iron and steel industry. The first is the abundance of high quality ore—whether the red hæmatites of central Sweden or the black magnetites of Lapland. The hæmatite ore, of up to 70 per cent iron content, is free from impurities such as sulphur and phosphorus. Phosphoric ores are found in Lapland and Grängesberg and these provide the material for export while the non-phosphoric ore is used in Sweden. Technical improvements have accompanied the expansion in the mining: from the original simple type of blast furnace using charcoal there has been an elaboration. Now concentration of the ore is done at plant such as that of Riddarhyttar in Bergslag. The Bessemer furnace was adopted and improved in 1858, the Siemen-Martin furnace in 1865, while the first successful electric blast furnace, using charcoal for reducing the ore, was set up at Domnarvet in 1909. Charcoal is still in use, for it gives a finer product than that from coke smelting. Steel, ferro-silicon and manganese-silicon are produced in electric furnaces. Using these fine steels Sweden has created an immense manufacturing industry, mostly working for extensive foreign markets, which includes products with world-wide names: *Primus* stoves, *Aga* lamps, *SKF* ball bearings, *Alfa-Laval* milking machines. Much of the credit for this activity must be attributed to the skill of engineer-craftsmen, the list of whom is headed by that mechanical genius Christopher Polhem (1661–1751).

At the beginning of the thirteenth century mention is made of Bergslag mines and in the 1280s the famous Stora Kopparbergs Bergslags Aktiebolag received its privileges and so can claim to be the oldest extant trading company in the world. Then came a period of active mining—copper at Falun, silver at Sala, zinc and lead at Åmmeberg. Copper exports began during the Middle Ages but were not important until later. In 1613 Sweden lost her war with Denmark and had to pay a heavy indemnity to recover Älvsborg, then her only western port; in order to raise this money the State monopolised the trade in copper and sold it abroad for silver, which was accepted by Denmark. Later the copper monopoly financed the Thirty Years' War. Falun was at one time the leading producer of copper in the world; in 1650, the year of maximum production, it yielded about 3,000 tons.[1]

Nickel was produced at one time but the low prices which have prevailed since the Sudbury mines were opened have forced the

[1] Although this tonnage is small compared with the modern Katanga output, it did dominate the European market with the only other considerable producer being Transylvania.

Swedish mines to close. Zinc-blende is mined at Åmmeberg but it could not be refined in the country until the introduction of electric smelters, owing to the great consumption of fuel.

The organisation of the mining and metallurgical industry varies from the small village workshop to the large company. Of the latter that of Stora Kopparbergs Bergslags Aktiebolag is noteworthy both for its long history and its many ramifications: for besides mining pyrites for its chemical works at Falun (which produce sulphuric acid and caustic soda), it owns half the Grängesberg mines, one-third of those

A.C.O.] [*August, 1948*

FIG. 52.—FALUN COPPER MINE.

The headquarters, containing the interesting museum, of the *Stora Kopparbergs Berslags Aktiebolag*. In front of the building is the cavity resulting from the spectacular collapse of the underground workings on midsummer day, 1687.

of Dannemora; it also created Domnarvet, the largest iron and steel works in northern Europe, exploited electric-smelting at Gysinge, and has forges for high-grade steels at Söderfors, pulp mills at Skutskär and the largest Swedish paper-mills at Kvarnsveden, using the produce of nearly a million acres (about 400,000 ha.) of forest, which was originally acquired to provide charcoal for the company's metallurgical activities. A modern non-ferrous metal producer of considerable significance is the Boliden Company operating in Norrland (see p. 150).

POWER

Apart from 250,000 tons of coal annually extracted from the small coalfield of Skåne Sweden lacks carbonaceous fuel. Fortunately this is compensated by the abundance of water-power, originally exploited by the water-wheel and now by electricity. The relief of the country with its many lakes and the well-distributed rainfall ensure a flow of water marred only by the long period of frost and the subsequent melt-water floods, while ungraded river courses provide numerous suitable sites for its exploitation. To the utilisation of water-power large-scale industry owes its driving force and without it many of the amenities of modern Sweden would be impossible, particularly in Norrland.

FISHERIES

Situated between the North Sea and the brackish waters of the "East Sea" or Baltic, Sweden has opportunities for developing a fishing industry, though not on the scale of that of Norway. The most important of the Baltic fisheries is the catch of strömming, a small herring about 8 in. (20 cm.) long. The west coast fishery is, however, of much greater significance and from the creeks of Bohuslän the North Sea is fished for herring (by trawls and seine nets), mackerel (by line) and other varieties. A feature of the herring fisheries is the irregular appearance of the shoals, the cause of the cycles being unknown: great fishing seasons occurred in the early fourteenth century, 1556–87, 1660–75, 1747–1808 and 1877–1900, and the greatest catch on record for Sweden was landed at Göteborg in 1787. Migrating eels are also caught and before the war were exported to Germany. Of the freshwater fisheries that of crayfish, a lobster-like crustacean, is the most important and provides a national delicacy. Salmon is also an important fishery.

INDUSTRIES

Sweden is distinguished from her neighbours by the scale of her industry which, in some commodities, is of world significance. Three main industrial areas can be distinguished: the south (glass, earthenware, sugar and oil refining, flour milling and textiles), the central region (where skilled engineering and wood-using industries are characteristic) and the north (where ore production, saw and pulp mills are dominant). Technical advances have often obscured the geographical basis of the location of an industry. Attracted by the supplies of raw material, iron manufacturers came to the Bergslag region and an iron and steel industry has been maintained for both the simpler processes, such as plate-rolling and wire-drawing, and

the more intricate, such as the tool manufacture which was founded at Eskilstuna by a Latvian immigré, Reinhold Rademacher, as long ago as 1650. The mechanical engineering workshops are not now confined to the ore districts but have extended to include, for example, mill machinery at Hässleholm, paper machinery at Härnösand, mine machinery at Stockholm and ships at Göteborg and Malmö. From the rock wealth granite is worked in Bohuslän for export, as well as for the home market; lime and cement are manufactured in Skåne, Öland and Gotland; clay is worked for bricks and tiles in the Mälar valley and south-west Skåne; and sand for glass in south-east Småland. The textile industry tends to be located at the ports as it is dependent upon imported raw materials, although some factories have been attracted inland to sites alongside rapids for the supply of power. Norrköping is the centre of wool manufacture and the Göteborg district for cotton. A number of the early woollen mills were established by Scottish immigrants. Many of the export industries are located in the west to avoid the winter closure of the Baltic ports. In Sweden, as elsewhere, individual industries are found to owe their development to natural conditions (which include the supply of raw material, power and fuel, and climate), to the labour available (which includes personal enterprise), to the availability of capital, to the geographical position in relation to markets and to the historical factors. However, Swedish industry is in general less tied to particular districts than that of many other countries, and is widely scattered over a number of towns.

State control over working conditions began in Sweden in 1864, when comprehensive control over the employment of women and children was instituted and this was followed, twenty years later, by a Factory Inspection Act. Under a law of 1934 Swedish workers may insure, through Friendly Societies, against unemployment but, by a law of 1913, are compelled to insure for old-age and disablement pensions; to help to pay for the latter the State created the Tobacco Monopoly.

The tourist traffic of Sweden developed late owing to the shortage of hotels for foreigners, but by 1957 it had reached considerable proportions with 507,000 non-Scandinavian visitors (chiefly German, British and United States citizens). The tourist season is short, extending from May to September; the granting of holidays-with-pay has made accommodation a problem. Sweden is generally regarded as having a favourable balance with tourism but newer methods of calculation suggest that there is a loss for the Swedes themselves are great travellers.[1] In 1960 509,000 Swedes travelled abroad.

[1] B. Lindman, *Skandinavisk Banken Quarterly Review*, Stockholm, July 1939, pp. 62–7.

TRANSPORTATION

Sweden is not well endowed with navigable waterways but efforts have been made since the fifteenth century to improve these by canalisation: unfortunately many of the early canals and the canalised waterways, like those of Britain, were made of too small

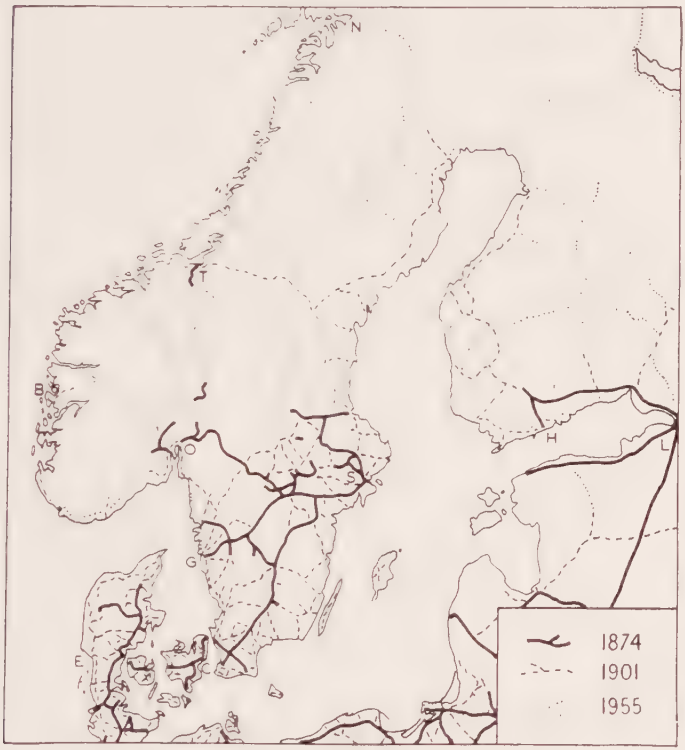


FIG. 53.—GROWTH OF THE RAILWAY RETICULE.

By 1874 the principal towns of southern Sweden were connected by rail but the less wealthy countries of Finland and Norway were later in constructing their network and in both these countries there is still some provision of new lines. Only the framework is shown on this map.

Based on *Bradshaw's Continental Railway Guide* and local railway histories.

dimensions to allow economic haulage and only in a few cases, such as the Trollhätte Canal, has enlargement been feasible. The provision of canals has been justified in the central belt, for by their agency the great lakes have been opened up to navigation by sea-going craft. The first canal in Sweden was constructed along the

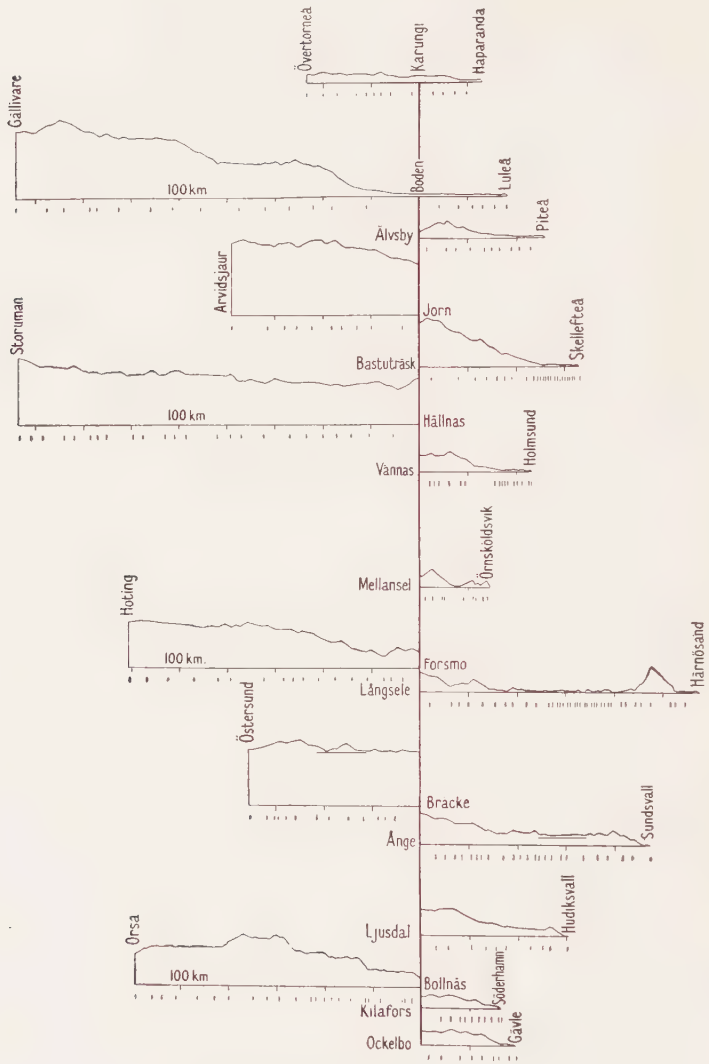


FIG. 54.—SWEDISH BRANCH LINES PROFILES IN NORRLAND.

From the line from Ockelbo to Karungi branches extend down and up the valleys which the northern main line crosses. Against the base-line of each branch a mark is made for each 20 km. while below the baseline the stations are indicated by vertical bars. It will be noticed that the lower parts of the valleys reflect the greater density of settlement by more frequent stations than occur with most of the upper valleys.

Based on engineering reports on lines and timetables.

Eskilstuna river between Mälar and Hjälmar and it is being enlarged to take vessels of 3,000 tons gross.

From the opening of the first railway, that from Arboga to Örebro, in 1856, Sweden has progressed until now she has 1·24 miles (2·0 km.) of line open per 1,000 persons. Many of the lines have been converted to electric traction, partly owing to the cessation of coal imports during two world wars, for the use of wood fuel lengthens travelling times and restricts the pay-load. The railways serve all the chief ports and connect them with the industrial regions of the interior. Norrland has been opened up by the construction of longitudinal lines, one close to the coast and the other, Inlandsbanan, farther inland, where it opened fresh territory not served by the ports and at the same time was less vulnerable to invasion from the east. From the north–south lines run out feeders to the Gulf of Bothnia and to Norway: the former have easy gradients but the latter, although following river valleys, have the main watershed to surmount and steep gradients down to the Norwegian coast. Of the transverse lines the most important is that joining Kiruna to Luleå and Narvik for it carries the bulk of the ore traffic. With the opening of the connection to the ice-free port of Narvik in 1902, the export of Lapland ore increased from 1·73 million tons in 1901 to 2·83 million tons in 1903.

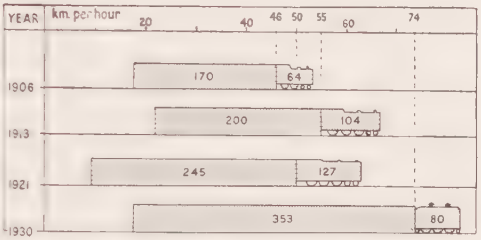


FIG. 55.—DAY EXPRESS FROM STOCKHOLM TO GÖTEBORG.

This diagram shows the increase in average speed and weight of trains and, with electrification, the increase of speed despite heavier trains and reducing the locomotive weight as a fraction of the total train weight.

Based on *Statens Järnväger, 1906–31*, Stockholm, 1931, vol. 1, p. 361.

Regular air services only started in 1924 but by 1938 Sweden was the seventh European country for air traffic as measured by ton-miles, being only exceeded by countries with long extra-European routes. This position was partly attained by the extensive services to London and Moscow, 1,865 miles (3,000 km.) (then the only air connection between western Europe and the U.S.S.R.) and by the intensive service between Malmö and Köbenhavn which was only second in Europe to that between London and Paris.

Sweden has a considerable shipping tonnage per head of population and this must be partly attributed to the bulky nature of her exports; timber is regarded as the item of world commerce requiring

most ship-tonnage. There are regular lines trading world-wide, while Sweden possesses a fleet of specialist vessels such as ore-carriers and oil-tankers which may never visit a Swedish port in the course of trade.

COMMERCE

Swedish economic life was of small importance to the outer world before the seventeenth century, and there was little foreign trade, even though it was assiduously nurtured by the Hanse merchants, and the consequences of Gustavus Vasa's action in putting an end to their privileges were less than generally believed. With nine-tenths of the population engaged in subsistence agriculture there could be but slight trading, and salt represented over one-quarter of the imports. Trade with the German Baltic ports dominated such Swedish trade as there was until the spectacular rise of the Dutch merchant class.[1] After 1613 copper became a major export, and during the first part of the seventeenth century Gustavus II Adolphus and his able Chancellor Oxenstierna discouraged the production of iron in favour of the "nobler" metals silver and copper. Later, iron dominated the exports and in the 1720s it contributed nearly three-quarters of the export trade. The limited amount of the total trade, however, is revealed by the fact that this iron export only amounted to 33,000 tons. Then followed a deliberate restriction of iron production, partly to maintain prices and partly to conserve the forests from overcutting for charcoal supply. From 1850 the forests were exploited for timber and by the 1860s its export had surpassed that of iron in value—though at the price of using the forest wealth accumulated over centuries.

The commerce of Sweden has changed a great deal since 1870, when she exported half a million tons of grain and 13,000 tons of iron ore and sold round and sawn timber. The grain crisis of 1875 turned farmers away from cereal production and replaced it by the production of dairy produce for export. There was a change in the iron-ore exporting industry, too, with the opening to commerce of the phosphoric ores of Lapland, and the export rose to 17 million tons in 1961. There has also been a turnover in the timber industry from crude timber to processed goods. Swedish life was transformed during the First World War when, with prosperous trade, she changed her economy from that of debtor to a creditor nation. With specialist products in world demand, Sweden has been more prosperous than most countries in the last two decades.

[1] This changed orientation of shipping routes partly accounts for the increase of traffic through the Sound in the sixteenth and seventeenth centuries.

CHAPTER 8

SWEDEN—REGIONAL

With a more numerous people and a more wealthy economy than the other nations of the Scandinavian World, Sweden has a variety of environments. Nevertheless it is possible to devise a simple but reasonable regional grouping on the basis of geomorphology and climate which, at the same time, finds justification in the varying facets of the evolution of the Kingdom. A threefold division into Norrland, Central and Southern Sweden forms a convenient framework for regional description and, although the precise location of boundaries may be a matter of some debate, it is found to be generally true for both physical features and economic development.

NORRLAND

Norrland is usually regarded as the territory north of the lower course of the Dal älv, but the southern fringe is transitional in character and will be treated with Central Sweden. It includes the Norrbotten county which has only been accurately studied in the last two generations. Norrland did not include Jämtland until this district was conquered in 1645. The frontier location was later emphasised by such raids as the Cossack looting of Luleå in 1716, of Piteå in 1716 and 1721 and of Umea six times in seven years. The loss of Finland to Russia in 1809 turned Swedish attention to her northern provinces, which had first paid taxes to the Swedish Crown in the sixteenth century and these provinces, about twice the area of Portugal, became the scene of active colonisation. Previously Norrland had been regarded as a barren, unfriendly land: for example Carl von Linné wrote in his *Iter Lapponicum*, after being snowbound in Umeå Lappmark: "Never can the priest describe Hell, this is much worse; never can the poets describe Styx, as this is much uglier."

The region has a general uniformity of summit-height, declining from north-west to south-east, and there is a regular drainage pattern. When the structure is examined it is found that there are three major longitudinal divisions: to the west the zone of fjäll associated with depressions, partially lake-filled; a central zone formed by a band of Archæan rocks with dissected plateau scenery; and an eastern zone consisting of a broad rim of recent marine

deposits mantling the coastal area and now raised up to some 900 ft. (270 m.) above the present sea-level. Uniting these three zones are the mighty transverse rivers which demonstrate the typical pattern of consequent streams; the greatest of these rivers is the Torneälv, which has only half its catchment basin in Sweden. These rivers are of great geological age but have been rejuvenated by recent uplift[1] and by glacial interference. Their thalwegs show a series of quiet reaches separated by rapids or falls which are a heritage of the Ice Age—sometimes resulting from morainic bars across the channel and sometimes from the deflection of the river into a channel in which it is not yet graded. A celebrated example was the Ragunda catastrophe of 1796 when the Indalälv ruptured a morainic barrier and suddenly reverted to its pre-glacial channel; the upper lake, some 12 miles (19 km.) long was emptied, a fall known as Hammerfors was created and a section, with a defile and a fall known as Döda (*Dead*) Fallet, was left deserted. Most of the waterfalls on the rivers are found in the middle and lower courses and few are found in the fjäll region. The volume of water in the rivers can be very great and their régime is reminiscent of alpine rivers with a heavy flow during the snow melt of early summer. The rivers unite the terrain and offer lines of penetration from the coast into the interior but, at the same time, by their incision divide the longitudinal zones into blocks.

Mountain Zone

The mountain zone is a region of great overthrusts for it is the denuded remnant of a great nappe; the Caledonian mountains, the roots of which are found in Norway, are not represented in Sweden. The highest ground in Norrland is in the west and is formed of schists and igneous rocks, but as a result of long-continued erosion the scenery is undulating and plateau-like and hardly mountainous. In the south the relief is not usually very high and only north of the Umeälv is there any great complexity of land-forms; here the nappes are formed of resistant material which has been heavily glaciated and the mountains of Kebnekaise (6,963 ft., 2,123 m., the highest in Sweden), Sulitjelma and Sarek are almost desert tracts which were unexplored until 1880, though they have now become well-known through geological and glaciological surveys. The northern limit of these highlands is marked by the Torneträsk depression of Lapland where the watershed is only 1,351 ft. (405 m.) above sea-level. Towards the east, the lower nappe is capped by syenite-quartzite and

[1] In Medelpad and Ångermanland the rate of uplift is, at present, 31–39 in. (0·8–1 m.) a century.

so protected from active erosion, creating to the east a cliff, up to 1,000 ft. (300 m.) high, known as the *glint*, overlooking a narrow outcrop of less resistant Silurian rocks.

To the west, therefore, are rock outcrops, eroded by former glaciers and still containing residual snowfields and virtually devoid of plant life. The syenite slopes are boulder-strewn and only in the favoured valleys are found lichens and dwarf willows. The

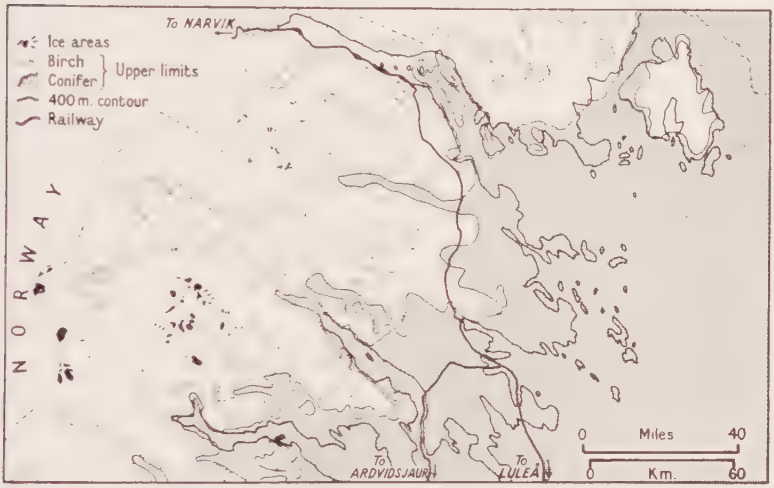


FIG. 56.—PART OF NORRLAND.

The upper limit of the conifer forest is generally above the 400 m. (1,300 ft.) contour while the upper limit of the birch picks out the main valleys in the fjell and isolated hills in the lower land.

Based on *Nordisk Familjebok* maps of Lapland and Vasterbotten and 1:500,000 maps of Sweden.

Archæan rocks to the east repeat for mile after mile an alternation of tarns, peat-bog and conifer forest according to the soils and the drainage. The rivers cross the grain of the country and in this section of their courses, at an elevation of 1,000-1,320 ft. (300–400 m.), are found lakes which, except in the Silurian belt, are long and narrow and have been formed by glacial dams. The largest of these lakes from north to south are shown in Table on p. 142.

The lakesides bear terraces which indicate a formerly greater depth of water. At the lower ends are towns, such as Strömsund, which serve as the transference point between rail and water services and so have acquired nodal functions.

Lakes of Northern Sweden

Lakes	Height above sea-level datum		Area	
	ft.	*m.*	*sq. miles*	*sq. km.*
Torneträsk	1,122	342	126	317
Stora Luleträsk with Langas*	1,238–1,214	375–370	88	220
Saggat and Skalka	994–968	303–295	32	82
Hornavan, Uddjaure and Storavan	1,402–1,371	425–418	264	661
Storuman	1,145	349	65	163
Vojmsjön	1,355	413	31	78
Malgomaj and Volgsjön	1,119–1,096	341–334	41	103
Flåsjön	873	266	44	112
Strömsvattnet with Dragan and Russfjärden	943	287	58	147
Hotagen	1,033	314	16	42
Landösjön	1,047	319	18	46
Kallsjön	1,257–1,247	383–380	62	155

* The levels are being altered by the construction of dams for hydro-electricity; in Akkajaure is a new lake, 37 miles (59 km.) long which replaces several smaller lakes.

Jämtland

Jämtland, centred round Storsjön, stands out in this almost uninhabited tundra and birch-clad fjäll region as a lowland oasis of fertility carved in Silurian sandstones and limestones (Figure 57). The morainic cover gives rise to a gently undulating surface and also, because of its lime content, fertile soils. When the land-ice retreated from Jämtland the sea invaded the Indals valley and formed a fjord as far as Stugun; deposits in this sea now stand up to about 750 ft. (230 m.) above the present sea-level. To the west a low col leads to the Trondheim depression and through this penetrate warmth and moisture brought by the North Atlantic Drift; the average January temperature of Östersund is 17°F. (−8·4°C.) which compares favourably with 11°F. (−11°C.) at the small town of Sveg, which lies at the same altitude but farther south in Härjedal. The basin has on its flanks alluvial terraces and these provide excellent summer pasturage which has led to a sæter system. On the fringe of the barren areas, as in Härjedalen, are mountain shielings, centred on grey cabins, to use the pastures. Usually the younger members of the family travel to the shieling and with modernisation the rigorous conditions are vanishing, though the value of the system continues.

Until the opening of the railway across the region in 1882 it turned more to Trondheim than to Stockholm for its well-being; even to-day some products are exported across the Storlien gap. This is the only railway crossing the frontier between Värmland and Norrbottens län but there are roads, some of which, e.g. from Härjedalen and

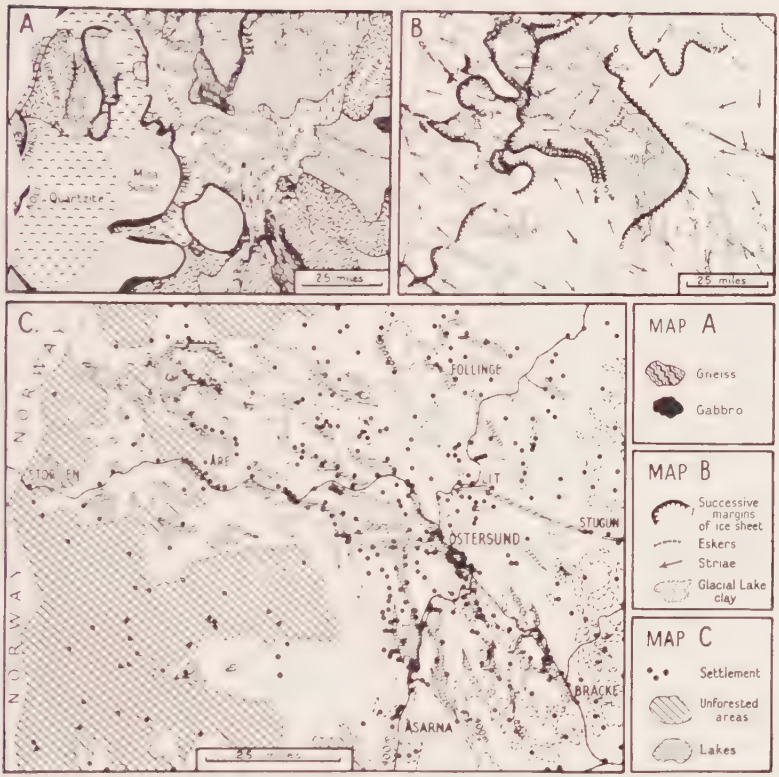


FIG. 57.—JÄMTLAND.

Map A shows the location of the limestone and Map B of the glacial lakeclays which have been so significant in the settlement of the region round Storsjön. This is an island of fertility in a district of complicated, but generally sterile, metamorphosed rocks.

Based on 1:500,000 and other maps of Sweden and on the geological work of Högbom.

Röros, are being improved to strengthen the links between the two countries, and new roads are planned.

Jämtland, for a period a pleasant republic, received many of its settlers from Norway before it became united with that country in the twelfth century. Ravaged by war, it passed in 1645 to Sweden

by the Treaty of Brömsebro. Östersund was established in 1786 to counter the attractions of trading by Trondheim but has failed to develop as an effective balance; nevertheless its railway, road and lake services, in conjunction with the agricultural wealth and tourist attractions round Storsjön, have made it the largest town in Norrland, other than Sundsvall and Luleå. It is situated higher (1,076 ft., 328 m.) above sea-level than any other town in Sweden except Kiruna.

Archæan Zone

East of the Silurian belt is a region formed of the Archæan rocks overmantled with morainic deposits. The country rocks consist of granite, porphyries, leptites and gneisses. This region has a monotonous appearance, with upstanding bosses and ill-defined drainage on the gentle slopes. The entire region was above the marine transgression except for the bottoms of a few broad valleys which extend in from the east. The morainic mantle is almost intact and is dominated by siliceous material, lacking lime, and contains many boulders which impede tilling. The climate, with its liability to frequent early frosts and summers too short for ripening, also handicaps agriculture and so much of the land has been left under coniferous forests. Pine was formerly the main type of tree but over-cutting has led to a diminution of the proportion. The impermeability of the soil, the very slight slope on the peneplaned surfaces and the humidity all encourage peat growth and explain why nearly one-third of the surface is classed as peat-bog. The marshy lands which occur on the slopes are known as *hängmyrar* (hanging marshes). Whereas the drainage on the slopes is ill-defined, great morainic barriers are absent from the valleys and this section of the river courses lacks lakes. During the period of maximum depression of the land the greater river valleys appeared as fjords and on the floors was deposited sandy and clayey material which, with the terraces formed during the spasmodic uplift of the land and the downcutting of the rivers, now favoured agriculture. However, while terraces line the main valleys and provide sites for farms, they are discontinuous, being cut by side streams entering the main valley.

The land away from the valleys is only occupied by small groups of forest-workers while the valleys contain an active local life in addition to that which they acquire as routeways for either railways or nomadic Lapps. These Lapps, although only numbering some 10,000, play an appreciable part in the life of this belt of Norrland and their route centres, such as Jokkmokk and Karesuando, have developed as trading points. The mountain Lapps live in a *kåta*, a

portable hut-tent, but as they become more settled the huts become increasingly substantial. Most of the nomadic Lapps are found in Lapland during the winter; in the summer many move to the west, where food for the reindeer is more plentiful. The Jokkmokk Lapps spend the summer in the mountains round Vastenjaure, north of 67° N., and travel south to winter near Lakaträsk, south-east of Jokkmokk, and in the hills round Jokkmokk. Of the Lapp population, under half remain true nomads and the rest have settled in villages. The Swedish Government has created holdings, for example that at Kurravaara, for Lapps who have become impoverished by losing their reindeer through abnormally hard winters when deeply frozen snow prevents the animals from reaching fodder.

Coastal Lowland

The alluvial rim is the most important sector of Norrland for it has played a fundamental role in the modern colonisation of the area. In the pre-historic past men penetrated into the fjäll but, judging by the paintings on a cliff of Flatruet (Härjedalen) of beasts of the chase, their visits may have been only for hunting. In 1921, the population distribution, as calculated by Ahlmann, was as follows: mountain area 1 per cent, Silurian area 10 per cent, Archæan plateau 22 per cent and coastal zone 67 per cent. This coastal belt prolongs to the north the favourable conditions of Uppland. On the east is a much indented coast with a skärgård of bare rocks. During the Ice Age the region was overwhelmed with morainic material and since then it has been covered by sea or lake waters. These seas stripped much of the morainic cover off what were then low islands, but now appear as hilltops, and re-sorted the material to form beaches. Later came uplift, as the weight of the ice was removed, and the beaches and deltas were lifted above sea-level as great terraces. The breadth and fertility of this plain varies along the coast. In Norrbotten the soil is formed of phosphorus-rich sediments, and there is a broad coastal archipelago, while near Skellefteå the plain narrows and there are few islands. At Härnösand the littoral becomes higher, the river estuaries are fjord-like in pattern and the alluvial sediments of the interior are rich in lime. While the soils vary in quality they are all fertile compared with those to the west and this, together with a maritime influence, creates an environment which has long attracted man. In pre-historic times man occupied the portion which had emerged from under the waters of the Gulf of Bothnia and later millennia saw the further clearing of the land by burning for agriculture. Only in the last century, when colonisation became most rapid, did this method of clearance finally

cease. At first the agriculturalist concentrated upon the driest deltaic deposits and it is largely in the last hundred years that the moister slopes and lowlands have been occupied. To-day settlement is concentrated in the river valleys and the pattern is one of isolated units of occupation separated by forest and bog. While towns have existed as legal units for centuries they remained sterile and backward until the era of timber and iron-ore extraction. There is a belt of denser population immediately next the sea where it can be readily served by shipping. With the increase in the size of ships and the silting up of the estuaries, partly brought about by uplift of the land, many old ports have had to be provided with an outport, for example, Holmsund, 8 miles (13 km.) from Umeå, and Ursviken 2½ miles (4 km.) from Skellefteå. The north–south railway had to be built inland to avoid crossing wide estuaries and the coastal towns, as a result, are served by branch lines, but inland settlements gained.

Dalarna

Dalarna, as large as Belgium, is a province of transition between the northern and central regions of Sweden. It is of great diversity for "Lower" Dalarna contains the industrially active district of Bergslagen (see p. 154) and "Upper" the barren fjäll rising to 4,000 ft. (1,200 m.). But for the deep dissection by the rivers Dalarna would have been a region of monotonous peat-bog and woodland; as it is the railways, which follow the rivers, end in cul-de-sacs and do not traverse the whole province as they do in Jämtland. Upper Dalarna, a regional entity, centres on Siljan lake; the nucleus of the region is formed of granite, surrounded by a ring of Silurian sediments. The granite outcrop is not inhabited whereas the more moderate climate and more fertile soils produced in the lower lands of the Silurian outcrop have a marked concentration of population. In this district, barley, oats and root crops flourish and the community can remain agricultural. The studies of Frödin show that *fäbod*, the equivalent of the Norwegian sæter system, lingers in Dalarna.

This region is also characterised by the particular dialects and costumes of the people, by the existence of domestic industries such as the manufacture of textiles and wooden articles, and by the architectural features of the many large and ancient farmhouses. All these features combine to make it one of the leading tourist districts of Sweden.

ECONOMIC EXPLOITATION OF NORRLAND

Norrland in the fourteenth century had the nuclei of several parishes but at the end of the Middle Ages, the total population was

hardly 70,000. When the mining industry was started at Nasafjäll about 1635, real colonisation commenced and, through the granting of privileges to encourage colonists, some fifty settlements had been established in Northern Lappmark by 1750. Through time not merely did the total number of inhabitants increase, but also the proportion of the total Swedish population contained in Norrland:

FIG. 58.—TIMBER FLOATING NEAR SUNDSVALL.

The width of the stippled lines is approximately to scale for the quantity of timber floated either down the rivers or in the Gulf of Bothnia. Cross-bars on the rivers represent points where the timber is sorted or taken from the water while the black circles locate the main sawmilling points with the size of the circle proportional to the capacity of the mill. Note how the Norwegian Swedish frontier does not always coincide with the waterparting. The ruling on the Gulf of Bothnia runs east–west.

Based on I. Winberg, *Flottgodsmängden i Norra Sveriges. . . år 1930*, Stockholm, 1933, *Sveriges Industri*, Stockholm, 1948, pp. 360–1 and 374–5, etc.

in 1750 the ratio was 1 in 12; in 1855, 1 in 8; in 1913, 1 in 6 (that is 1,101,000 out of 6,162,000); still in 1961 at 1 in 6 with an intervening decline to 1 in 7. This variation in the proportions shows that Norrland was for long increasing more rapidly than the rest of Sweden. The expansion of activities was not unhampered by political, as well as by physical conditions, for between the years 1636–1756

the Merchant Guild of Stockholm secured restrictions on trading in Norrland. For centuries, although sawmills existed, the chief interest was in the export of resin and tar and not until 1850 did the modern activities concerned with forests, minerals and water-power

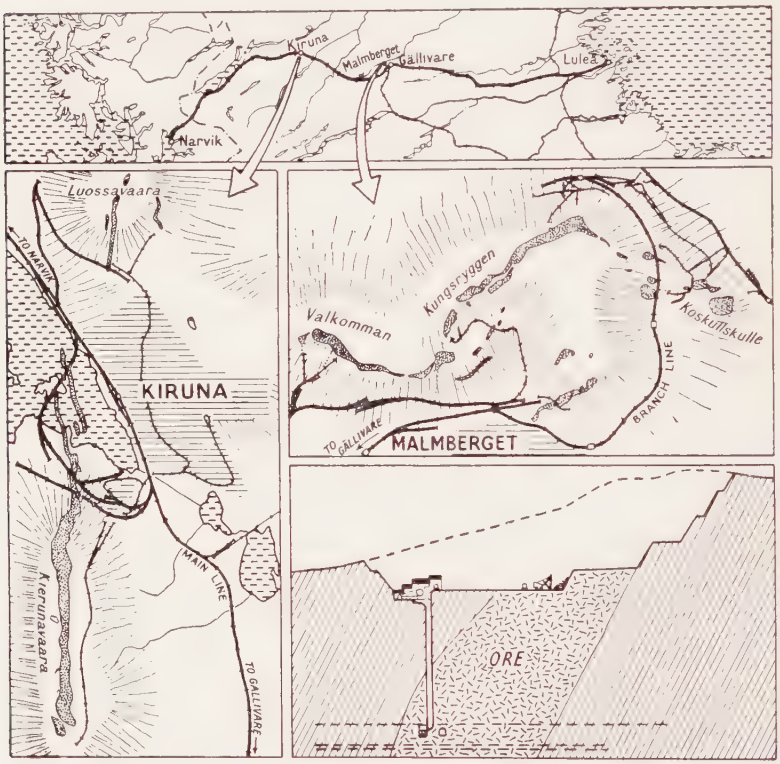


FIG. 59.—KIRUNA AND MALMBERGET ORE-BODIES.

The ore outcrops are marked by a stipple. In the bottom right hand is a cross-section of the lode which was worked by quarrying; the crushed ore is fed to trucks down a shaft and evacuated through a tunnel. Townships horizontally ruled and water shown by pecked lines.

Based on Statens Järnvägars Resehandböcker; *Övre Norrland, Riksgränbanan*, Stockholm, 1931, pp. 49, 58 and 66 and 1:100,000 maps.

begin to attract capital and people into the region. The enormous expansion of the sawmill industry in the 1860s led to the development of large companies working thousands of acres of forest land with a systematic organisation of cutting, floating and charcoal burning connected with saw and pulp mills; the latter, to warrant the considerable capital expenditure, had to draw on a vast district

and so found their natural siting near the mouths of the river basins. The estuaries of the Ångermanälv, Indalälv and Ljungan are close together and, as these are the basins richest in timber and water-power, the Swedish wood-using industries are concentrated on this section of the coast. In the north where tree growth is slowest, much territory is owned by the State which now effectively controls cutting of the forests.

The mineral exploitation has been vast. The five chief iron-mining centres of Norrbotten, all grouped round Gällivare and Kiruna, are Malmberget, Koskullskulle, Kirunaavara, Luossavaara and Tuolluvaara, and the Gällivare ore is concentrated at Vitåfors. Previously the whole output of the ore was exported *via* Luleå in summer and *via* Narvik all the year round but for years now there have been smelting plant at Luleå. The development of this ore-field illustrates the difficulties of operating in Norrland. Gällivare iron-mountain was discovered in 1704 and was worked some years later but little could be done owing to the cost of transporting the ore by reindeer to Strömsund iron-furnaces. In 1818 it was proposed to join the rivers Lina, Ängeså and Kalix by a line of canals and nine years later it was proposed to join Gällivare to Storbäcken on the Luleälv and thence carry the ore by water to Luleå. In 1819 1,250 tons was mined but by 1860 the quantity was reduced to 50 tons owing to the increased charges of transporting ore by reindeer. In 1862 the Gällivare Company was formed to work the timber and ore and to construct a railway from Gällivare to the Luleälv (60 miles, 96 km.) and then with two short canal links to use the river to reach Gäddvik harbour. One of the numerous difficulties experienced by the company was that of attracting labour, even then in short supply in Sweden; workers were unwilling to endure the severe climatic conditions. Until the opening in 1891 of the railway to Gällivare it still proved impossible to exploit the ore but since then the output has been tremendous. The modern significance of this great iron-ore district to European industry is dealt with on p. 433.

Another ore-body in the north which has been developed is that in the Skellefteå district which was discovered by modern geophysical prospecting technique. The Ice Age left the Skellefteå orefield buried under thick deposits of drift and prospecting had to be largely based on gravimetric and electro-magnetic methods: unfortunately some of the schists contain graphite, a good conductor, and needless diamond-drilling followed in the belief that the ore-body extended more widely. There are two main lodes, parallel with each other, at Boliden, and the ore is obtained by stripping the 70 ft. (21 m.) thick overburden and quarrying from open pits or mining by

stopes. The Boliden ore mass contains ½ oz. (14 g.) of gold and 1½ oz. (42 g.) of silver per metric ton, 1½ per cent of copper and up to 25 per cent of arsenic.

In view of the great metal shortage, particularly of copper, at the end of the First World War, the Boliden Company was formed and work at the site commenced in 1925 and in five years the company was ready to extract the metals at its own smelters at Rönnskär, near Skellefteå. In 1934 18,110 lb. (8,217 kg.) of gold was produced and before the Second World War the annual output of gold was three times the total amount produced in Sweden in the five centuries preceding 1926. The ore also yields, from sulphide compounds, silver, bismuth, selenium, cobalt, nickel, lead and arsenic; the last is a troublesome product as the quantities are greatly in excess of world demand and its storage has required the construction of vast ferro-concrete warehouses to prevent its entering the Gulf of Bothnia or the

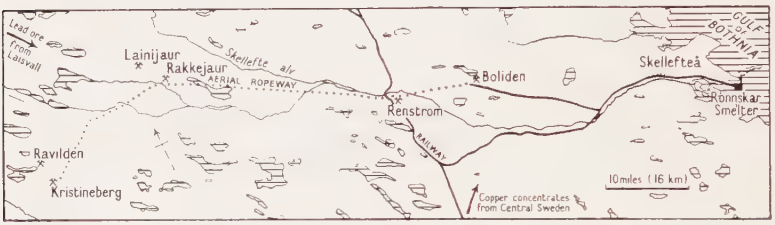


FIG. 60.—MOVEMENT OF ORE TO RÖNNSKÄR SMELTER.

By means of aerial ropeway and railway ore is brought to the great smelter at the mouth of the Skellefteälv. Water shown by ruling.

river. Active research is being prosecuted to find uses for this by-product; its widest field of use at present is for impregnating wood and for insect sprays.

Further exploration has located other ore-bodies in the province of Västerbotten. At Kristineberg is now produced a concentrate containing 26 per cent copper (from an ore containing 1½ per cent), a zinc concentrate with 56 per cent zinc and a pyrites concentrate with 51 per cent sulphur. Until 1943 these concentrates were hauled 60 miles (96 km.) by road to Boliden, but this transport is now replaced by a double aerial-ropeway, the longest in the world, which links all the known ore-bodies of the district with Boliden railhead; the capacity of this ropeway can be increased to half a million tons a year. The construction of this transport system allowed 112,000 tons of pyrites tailings, hitherto regarded as worthless, to be sent south and so reduce the Swedish annual import of a quarter of a million tons of pyrites for the sulphuric acid and pulp works. At

Laisvall, 70 miles (112 km.) from a railhead, a new lead-mine has been opened with a 360 ft. (108 m.) deep shaft from which 100,000 tons of ore a year can be extracted. This ore is concentrated by grinding and flotation to 82 per cent lead before being transported 200 miles (320 km.) to the Rönnskär smelter. Before this mine could be operated Ringsele hydro-electric power station had to be constructed by the company.

From Laisvall, Adak, Kristineberg, Rävliden and Boliden a stream of ore pours to Rönnskär while from central Sweden, too, copper concentrate is shipped to the smelter, and for a time Petsamo nickel ore was also sent to this giant metallurgical centre. These incoming ores to the smelters at Rönnskär and Hamnskär, about 12 miles (19 km.) from Skellefteå, helped to increase the population of the port from 3,000 to 11,000 in the twenty years after 1925. To maintain operations in winter the ore storage-bins are heated. From the bins the ore is carried to roasting furnaces, to remove the arsenic, and afterwards to the reverberatory furnaces where it is reduced by birch logs. Since 1933 the copper has been electrolytically refined from the other metals.[1]

The social consequences of a powerful company, such as is necessary to develop these isolated sites, are immense and the directorate have planned the mining towns with care and provided community services in what was recently primeval forestland. No other Swedish community has grown so rapidly as Boliden and within twenty years 2,500 persons settled in this formerly isolated area.

Without water-power the exploitation of the forests and ores would have been difficult, if not impossible. The first hydro-electric station in Norrland was established at Härnösand in 1885 and since then there has been progressive use of the potential to meet the requirements of particular projects: for example at Porjus, harnessing a series of falls nearly 2 miles (3 km.) long to serve the iron ore-fields of Gällivare and Kiruna. To counteract the climatic severity the water is taken from below the surface and the power-house of Porjus is situated 165 ft. (50 m.) underground where it is insulated from winter cold; as a result the capacity of the station is limited by the size of the tunnels required to carry the tail-race downstream. The latest of the great sites to be developed is that of Ligga, 20 miles (30 km.) north of the Arctic Circle, where the Stora Luleälv drops 676 ft. (206 m.) in a series of falls; the hydro-electric power-station has been joined by a new high-tension link with Malmö.

This industrial development has caused profound changes in the

[1] To prevent damage to the forest from fumes, such as occurred at Trail (British Columbia), the smelter has the tallest chimney in Europe, 480 ft. (144 m.).

life of Norrland and has given the region a new significance in the economy of Sweden. Before the timber era, nine-tenths of the scanty population was engaged in agriculture or pastoral farming. In Jämtland, a district better favoured for agriculture than any other part of Norrland, the proportion interested in agriculture fell considerably after 1840. With only 4 per cent of the land suitable for farming of all kinds the north requires to import great quantities of grain, flour and fats, as well as colonial produce. Its exports are bulky and so the railways and ports are adjusted to handle vast

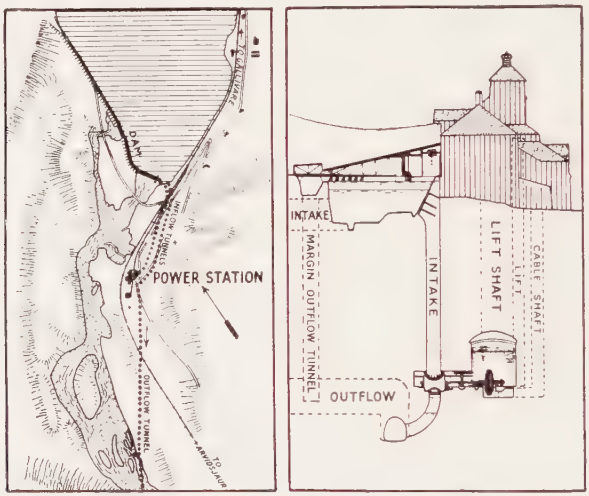


FIG. 61.—PORJUS POWER STATION.

There is a series of rapids and falls with a head of 55 m. (180 ft.) below Stora Porjusselet now the Stora Luleälv has been dammed at this point and the main powerhouse equipment is placed underground in a rock chamber which gives protection during winter.

Based on Statens Järnvägars Resehandböcker; *Övre Norrland, Riksgränsbanan*, Stockholm, 1931, pp. 91 and 95.

tonnages. Of the numerous ports Härnösand, south of the Ångermanälv, although with little traffic, is one of the best, with deep water.

Changes in Norrland are reflected in variations in the pattern of settlement through time and this can be illustrated for a non-mining district from the monograph by Enequist on the lower Lule valley. In this district the upper section of the valley is bounded by sandy terraces while downstream the former bay is now a broad lowland formed by uplift of the land, at a rate of some 36 in. (93 cm.) a century. Terminal moraines, running north-west to south-east, are found in the Boden area. An early map of 1645 reveals that the original villages were normally on the gravel moraines and lay above

the level of sand and clay flats. These early villages, of a very irregular plan, were located near a lake and marshland pastures. After 1820 the pattern was broken up by legal division of the land and, instead of being nucleated or on a linear plan along gravel ridges, settlement became scattered on the holdings. Until the introduction of roads and railways, the river was the main artery, but the construction of these new routeways tended not so much to create new villages as to enlarge those along the new routes. Boden was fortified in about 1900 and acquired the character of a garrison town. The traditional activities of the district, in addition to agriculture, were fishing, hunting and tar distillation, but the two last declined with the growth of modern forest industries. The only community of this district dependent upon fishing is Laxholmen which belongs to the town of Luleå. In the past seals used to be caught on the ice in the Gulf of Bothnia for the sake of the train oil which could be rendered. Luleå, which received its privileges in 1621 has grown in size from the opening of the railway to the ore-fields in 1891 and now has an outport at Svartön, 2 miles (3 km.) away. The iron-ore loading plant is capable of loading 35,000 tons in 24 hours and a ship of 10,000 tons d. w. can be loaded in eleven hours. In winter the ore is placed in a stock-pile and reloaded into wagons by a mechanical shovel when navigation is resumed: the loading piers are 40 ft. (12 m.) high and the ore is tipped into the holds of the vessels floating in water with a depth of 26½ ft. (8 m.). Although the capacity for handling ore is so great it is estimated that the daily capacity for general goods is only a thousand tons. Unfortunately the port is generally ice-bound from early in January to the end of April. The story of increasing activity still unfolds and the smelting works at Luleå, established in 1906, marked the beginning of industrialisation.

CENTRAL SWEDEN

This, the heartland of Sweden corresponding very largely with the ancient provinces of Svealand and Götaland, falls with its great variety of structure and relief into a number of smaller units. While the lowland of Central Sweden extends across the country in a wide belt it is not a continuous plain but, having been much faulted, consists of three large separate regions namely the Mälar-Hjälmar plain, the Väner plain and the Östgöta plain east of Vätter. These plains, with their clay soils, have been formed by downfaulting along lines trending either north and south or east and west, and are separated by higher, stonier and more sparsely cultivated districts. Thus examination of Central Sweden is best made by comparatively

small units which are frequently bounded by waterpartings and coincide with administrative areas, ancient or modern. The soils of the plains, overlying drift derived from Cambrian and Silurian limestones and sandstones, tend to be stone-free, and owing to their low elevation, they were protected against ice-stripping action. The soils of the Mälar plain contain limestone carried by the inland ice from a Cambro-Silurian centre in the northern Ålands area in the Baltic. As a consequence of glacial retreat great esker ridges run across the country, frequently north and south. These sometimes form convenient routes; but the Göteborg–Stockholm railway, which runs obliquely to the trend, has a distinctly undulating profile in the section south of Mälar.

Climatically this region has variety: the average January temperature of the west coast is about 32°F. (0°C.) while south of Hjälmar it averages 25°F. (−4°C.) but conversely the west coast is slightly cooler in July. The effect on agriculture can be appreciable, for in Uppland the risk of frost damage to growing crops is greater than in Bohuslän. Owing to salt carried in by prevailing westerlies the natural vegetation, despite the advantage in temperature, is not so luxuriant along the west coastal fringe as along the Baltic shore. The climate rapidly becomes more severe on the border of Norrland and is also slightly more severe on the flanks of Småland than in the plains.

Although there are many physical facets to Central Sweden there is a certain community of interest given by the industrial activity: towns have grown up, transport and other services are provided and the tempo of life is vigorous, except in the dales without minerals or water-power. The lake region, with its fertile plains, is separated from Norrland by a transitional zone which spans the country from the Norwegian frontier to the Baltic. It is a zone of harsh climate, of upland lakes, of waterfalls, of bogs and forests which belong to the botanical province of Norrland. The human character of this transitional zone is given by the mineral deposits which, worked continuously from mediæval times, have created in the forests industrial units very different from those situated on the coalfields of Europe. The industrial works associated with the minerals and the forests are scattered widely, not being found in great urban agglomerations, and few, if any, towns lack an industrial activity. Peripheral though it be to the lake belt, this is the core from which sprang so much of the modern wealth of Sweden and where her mechanical genius was nurtured.

Bergslagen

Bergslagen, covering 5,800 sq. miles (15,000 sq. km.) in the district south-west of the middle Dal valley, is a region of marked character,

which has played a large part in the industrialisation of Sweden. The boundaries do not coincide with any of the ancient provinces of Sweden, for the region is not differentiated by relief and its character was not evolved until the mineral deposits were exploited. At the end of the Middle Ages the two centres of mining in the country were Falun (copper) and Sala (silver), "the Treasury of Sweden", and from these centres mining activity radiated. Each of these mining

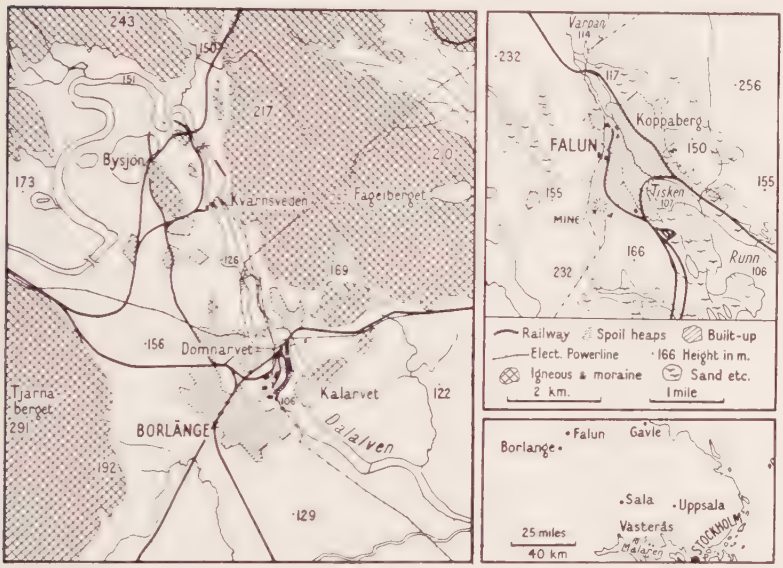


FIG. 62.—BERGSLAGEN.

Some of the features of this industrial district are shown; the rapid drop on the Dalälven at Domnarvet, the uneven surface with the higher ground formed of granites (frequently masked by moraines) and the Falun mine with its large spoil heaps.

Based on *Sver. Geol. Unders.*, map of Falun, 1 : 50,000, 1948.

communities, modelled on the German *Rammelsberg*, in the Harz mountains, possessed mining and forest rights, with villages to supply food and transport for the miners, smelters and founders.[1] It was from the great number of these communities that the region took its name. Bergslagen is geologically a district of leptites set in the gneiss of eastern Värmland, south Dalarna and the west and north of Västmanland, and these rocks contain veins of ores of gold, silver,

[1] In many ways these communities resemble those which developed to work the non-ferrous lodes of Cornwall or to work the iron-ore and coal deposits of the Forest of Dean.

lead, copper, zinc, manganese and iron. In the north the ground rises to about 1,640 ft. (500 m.) whereas in the south the hills are less than half that height. The surface is thickly forested or has peat-bogs and there is little land devoted to agriculture; an average of 140 days with frost in a year does not encourage arable farming.

The rivers, cut down to more than 300 ft. (100 m.) below the general level, are not yet graded and there are numerous waterfalls. In the past every stream had its water-wheels, the power of which was transmitted by wooden rods, to aid mining by pumping out water; but now hydro-electricity is the source of power for the metallurgical industries. The quantities of ore mined in the past by primitive means were enormous; the Falun workings, which now mainly produce pyrites for chemical manufacture, have yielded about half a million tons of copper. With the exhaustion of the more prolific lodes of better ore these communities, dominated by the manors of the old-time iron-masters, would have died but for the invention of the Thomas process of treating phosphoric iron-ore and but for the new timber-using industries. The mining of the phosphoric ore in Bergslagen takes place between Grängesberg and Idkerberg and the ore is exported by rail to the port of Oxelösund where 16,000 tons can be loaded in a day. In 1914 a smelting plant was erected at this port to take advantage of the availability of coke carried as a cargo by the ore-carriers.

FIG. 63.—SECTION OF IRON-ORE AT GRÄNGESBERG.

This is a small sample, with vertical and horizontal scales identical, of the nature of the iron-ore deposits. Extraction involves the removal of much waste material.

Based on *Sver. Geol. Unders.*, Ser. Ca., nr. 35, 1943, Tavl. 25.

Originally Bergslagen was isolated and so in the eighteenth century the Kolbäcksä was canalised (Canal of Strömsholm) and although this is now disused, the whole course of the river, into the heart of Bergslagen, is marked by industrial works. Without the railway network, however, this isolation would have prevented modern industrial life from developing. The metallurgical centres of importance include Domnarvet, the Bofors gun factory and Hagfors. The iron companies early acquired forest holdings for fuel and in

their attempts to conserve supplies of charcoal became pioneers of good forest practice.

Lower Dal Valley

To the east of Bergslagen, around the lower course of the Dalälv, is a district of more moderate climate which, however, is still not suitable for growing bread cereals. Along the flanks of the eskers grow deciduous trees—oak, lime and ash—which contrast with the surrounding conifers. This low-lying district has focused on the port of Gävle since the railway to Dalarna was opened in 1859. The Dalälv, and its neighbouring streams such as Gävleån, are useless for navigation but are vital for timber floating and have been harnessed for power. Their valleys do provide routeways connecting the industrial centres which have existed since the seventeenth century. In the last hundred years these centres have been revivified by the vigour of local industrialists; for example, at Sandviken a Bessemer steelworks was established in 1860 and the place to-day is famous for its saws. In and around Gävle, most ancient of the towns of Norrland, are grouped pulp- and paper-mills and cotton textile mills. To the south-east of the Dalälv are great sawmills of which that at Skutskär, owned by Stora Kopparberg, is claimed to be the largest in the world. These wood-using industries are fed by timber floated down the rivers or along the coast of Norrland. Near Krylbo, situated at the great bend of the Dal, are further iron and steel works using hydro-electricity. The capacity of the electricity plant is beyond the requirements of the district, even taking into account the great amounts used in the steelworks near Krylbo, and so Älvkarleby and Untra, among the largest power-stations of Sweden, supply power to Stockholm.

Värmland

To the west of Bergslagen and north of Väner, between Kristinehamn and Åmal is a gneissic plateau with many north–south faults. The rivers have eroded along these fault zones and so the district has settled valleys with intervening forest slopes and peat-clad summits. The water-mass of Väner is sufficient to ameliorate the climate in the south of this district but the north is as severe as in Bergslagen, so for long it was a pastoral district which helped to feed the miners to the east. Between 1580 and 1650 Finnish colonists, brought in by Charles IX, arrived in the district, and traces of their immigration can still be found in place-names and personal characteristics, although the language spoken by their descendants has become Swedish. They reclaimed land on the morainic deposits of the upper

Klarälv valley but Värmland still remained a poor, isolated province. At first these Finnish colonists destroyed the forests for agriculture but, when the value of the timber for charcoal was appreciated, antagonism sprang up between the Finns and Swedes in this upland. The Klarälv, without lakes in the Swedish part of its course, is subject to violent floods in spring and the floodplain is marked by the scars of changing meanders; the farms and roads are set above the risk of flood but the arable fields may be inundated. With the opening of the Trollhätte Canal in 1800 contact with the outer world was greatly improved. To-day there are found here wood-using industries, and near the shores of Väner, the great sawmills of Skoghall and a host of pulp- and paper-mills. The rivers enable man to tap the forest wealth, and the timber floated down them, after passing through the mills, is exported *via* the lake and canal navigation. Karlstad is the focal point of the district and the port can handle vessels drawing 16 ft. (5 m.). In contrast to the growth of these industries, there has been a severe loss of population from the rural districts; some people have migrated to the towns and others to the United States.

Lake Plains

The lake plains of Central Sweden contrast markedly with the plateau heights of Norrland and Småland, for only one-tenth of the area is higher than 656 ft. (200 m.) and only two-fifths exceed 328 ft. (100 m.). The numerous faults, orientated east–west and north–south, besides foundering the region as a whole, have created lakes against the up-tilted edges of the blocks and have caused rivers to be deflected. The horsts have developed as a feature of the relief by differential erosion. Across the plains are many traces of the Ice-Age—eskers, *roches moutonnées* and ground-moraine—but they tend to be modified by post-glacial submergence. Immediately above the limit of submergence, and therefore of marine alluvium, is an abrupt change: tilled land gives place to wood and pasture on the rock-ridden soils. The eskers, which are orientated north-north-west to south-south-east, have played a big part in the evolution of the region: they diversify the landscape, change the course of rivers, hold up lakes, and give sites for routeways and settlements. The post-glacial marine transgression laid down red clays in the Yoldia Sea and sands and clays in the Ancylus Lake and the Littorina Sea and these provide the basis of heavy soils which favour agriculture.

North of Mälar and Hjälmar is a region which climatically is a transition between continental and maritime influences, with a vegetation distinguished from that of Norrland by many deciduous

trees. On the clay soils agriculture is prominent, with the cultivation of wheat and sugar-beet. This region is open towards the Gulf of Finland, but is crossed by north to south routeways following the great eskers. When man first entered the district of Svealand he lived at the edge of granite islets, hunting and fishing; but as the sea retreated, agriculturalists from the south moved in to occupy the heavy but fertile clay-plains and established a settlement at Birka, the first town in Sweden. To-day the few hills, which were islands in the Ancylus period, rise above the sea of clay. Gamla Uppsala, prehistoric capital of Svea, was located at what was then the head of navigation of the Fyris river. With continued uplift port activity was moved to the outport, now known as Uppsala, but by the thirteenth century, before dredging, Uppsala was an inland town 8 miles (13 km.) from the limit of navigation. About this period, towns were increasing in the district either as centres for trading or as ecclesiastical centres and the region generally was accumulating wealth as German miners opened up the Bergslag district. By 1819 the wealth and the need for better transport had caused the construction of canals which gave the opportunity of further commercial expansion.

Mälar, the water surface of which is only 14 in. (35 cm.) above the level of the Baltic, has about the same area as the county of Orkney in Scotland. The whole of its overflow, except for the leakage through the Södertälje Canal, escapes across the esker ridge by Norrström and so flows through the centre of Stockholm. When the snows melt a torrent passes to the Baltic, but when the lake level is low after a drought, and easterly winds prevail, the current is reversed and brackish water enters the lake. The volume of water is sufficient to soften the climate of the shores and of the many islands. The shape of the lake with elongated, parallel peninsulas is due to intersection of several eskers by the water. Hjälmar is smaller and has fewer islands than Mälar. It is situated about 69 ft. (21 m.) above the level of Mälar, to which it is now connected by canal.

Mälar separates different types of terrain: to the north is the flat, agriculturally rich province of Uppland. A feature of this area in the last century and a quarter has been the dispersal of farms, each on its own land away from the villages, in a manner reminiscent of Denmark. Uppsala[1] is the only town of significance. Once capital of Sweden, with roads running to it along eskers, it lost its administrative function to Stockholm in the fourteenth century, and much of its ecclesiastical importance with the Reformation, but it still remains a market and manufacturing centre and is the home of the oldest university in Sweden and of the archbishopric.

[1] The town was called Aros or Öster Aros until the archbishopric was moved there in 1270: Västerås is a contraction of Väster Aros.

Uppsala, although only an hour's journey by rail from Stockholm, is a railway node. To the east of Uppland lies the small district of Roslagen from which the Vikings set out on their expeditions to Kiev and the Black Sea.

West of Uppland lie the plains of Västmanland also an agricultural region but more broken by extensions of the wooded ridges of Bergslagen. The proximity of the iron-workings resulted in the engineering activity of the ancient towns of Köping and Västerås; at the latter are the shops of ASEA (Allmänna Svenska Elektriska AB.) which is the leading Swedish producer of electrical motors, turbines

A.C.O.] [*April, 1953*

FIG. 64.—FARM BUILDINGS AT EKEBY, NEAR UPPSALA.
These are part of a typical holding with forests on the infertile deposits.

and transformers. Västerås, standing at the junction of old routeways, became, in the Middle Ages, an administrative centre in the shelter of its castle and cathedral.

South of Hjälmar and Mälar is Södermanland, broken in relief with fault-line scarps. Here are many ancient centres and one of these, Eskilstuna, a pre-historic settlement site, became, through the action of Charles X Gustavus in 1654 in encouraging German technicians, an arsenal, and its many workshops draw power from Hyndevads ström. To the east of this province is Södertörn, a triangular peninsula, now invaded by the suburbs of Stockholm and crossed by the railway to the outport of Nynäshamn. This peninsula is cut from the mainland by the ship canal of Södertälje which

taps the navigation of Mälar and has practically turned this lake into an arm of the sea. This canal was opened in 1819 and deepened to take vessels drawing 18 ft. (5·5 m.) in 1924, after it had been acquired by the State; it benefits the rich iron mines and works of central Sweden by avoiding the detour to the Stockholm entrance from the Baltic to Mälar.

For the most part Södermanland and its neighbour Närke turn away from the lakes and tend to focus on such towns as Örebro and the ancient stronghold town of Nyköping, although for long the area has been affected by the growing influence of Stockholm. Heavily glaciated, this country was originally clothed with thickets of birch, alder and conifers with intervening patches of meadowland. It is, however, an area of old castles and manor-houses which emphasise its routeway location during the centuries. Trunk railway lines from the capital to Göteborg and Malmö keep the pulse of life active. Unlike Norrland the wood-using industries, not fed by great watercourses, remain in small and scattered units. Nyköping has lost some of its importance in recent years as it is only one and a half hours by rail from the capital; while the port has lost traffic to nearby Oxelösund whose harbour and approach are not so liable to closure by freezing. Närke, around the western end of Hjälmar, is one of the more densely settled districts of Sweden. Its chief town, Örebro, is a strategic routeway centre where a river crosses an esker, and the town is sufficiently remote from Stockholm to retain a commercial life of its own. Formerly Arboga was the dominant city, although lying outside Närke, but it lost significance as a centre when it was by-passed in the seventeenth century by the canal between Mälar and Hjälmar. Owing to its nodal position in the railway pattern, Örebro was selected by the State Railway Administration for mechanical workshops.

Stockholm

Forming the focal point of the eastern part of Central Sweden is the city of Stockholm. This seven-centuries-old capital was first mentioned in records[1] when, in the middle of the thirteenth century, Jarl Birger constructed his castle to prevent Karelian and Estonian pirates from ravaging the rich Mälar plain; before the construction of the castle hostile fleets had several times broken through into Mälar and devastated the ancient towns of Sigtuna and Birka. During this same century Lübeck merchants developed trading activities and the Hanse merchants retained until 1471 some control over the administration. The city site is well-favoured æsthetically, with low hills interwoven with water, and man has made good use of

[1] Tradition connects the foundation with the destruction of Sigtuna in 1187.

the site for urban development. Few capitals are so delightfully located, though with the changing relationships of the States surrounding the East Sea Stockholm is now off the main channels of traffic.

The original nucleus grew up at the point where the Brunkeberg esker crossed the exit of Mälar waters into Saltsjön and also where fault-line scarps and lakes focused routes from the west. Until the fourteenth century Stockholm was confined to the island of Staden and although it expanded with enlargement of the city walls, it was not until the seventeenth century, when invaders could at last be repelled, that houses could be built safely on the mainland. The Vasa monarchy, particularly Gustavus Adolphus, encouraged the expansion of the city, and to permit this released ecclesiastical land in Norrmalm, so that the city burst its mediæval bounds. As time passed the central core, as in all old European capital cities, lost population while administrative and commercial functions grew. The first half of the twentieth century has seen a further spread encouraged by the cutting of Kungsgatan through Brunkeberg ridge and by a special clover-leaf construction at Slussen which removes obstructions to north–south traffic crossing the central water channel. Housing has spread even on to the inner islands of the skärgård. Rapid, indeed, has been the increase of population and the city, which now contains one-tenth of the population of Sweden, ranks second in population to København among the cities of Scandinavia. To the north-west and south are the industrial suburbs while the north and east have been developed as garden suburbs. The built-up area now extends widely over a very accidented site with numerous ice-scraped, rocky bosses up to about 100 ft. (30 m.) high.

The port is situated where the islet-studded sea and inland waters come together at the isthmus separating Mälar from the Baltic. The spread of summer villas has reached to Saxafjärden but the outer fringe, 30 miles (50 km.) east of Stockholm, is still as desolate as ever —bare with but a scanty cover of ling and dwarf juniper except in crevices where shelter is found and soil has accumulated. These outer skerries, with their narrow sounds and fringing reefs, took a heavy toll of shipping before they were properly charted and lighted. During the last century fishermen, whose cabins clung to sheltered crevices in the gneissic islands, caught strömming and rowed the catch to Stockholm, but these folk have died out and the huts are largely deserted. Between the skerries and the islands of the Skärgård are many approach channels to the port with a depth of over 20 ft. (6 m.), and although these and the harbour freeze from December to March, they can be kept open by ice-breakers unless there is drift ice in the Baltic seaway. Nevertheless the provision of

railway connections has proved a blessing to Stockholm, as also has the outport of Värtahamn, which has deeper water which can accommodate the largest vessels able to enter the Baltic and deals with the import of bulk cargoes of coal, grains, feeding-stuffs, fertilisers, non-inflammable oils, herrings and salt and the export of timber, woodpulp, and iron-ore. The port works are a combination of sheltered natural creeks and artificial construction.

In the early days the German influence was so strong that Stockholm almost became a Hanse town engaged in trading rather than

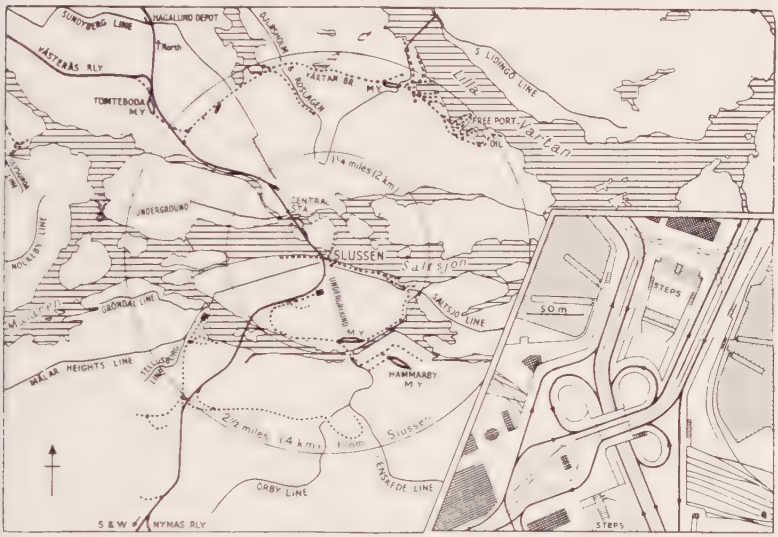


FIG. 65.—TRAFFIC NODES OF STOCKHOLM.

Note the congestion at Slussen and how pressure has been relieved for road traffic by a clover leaf and for the railway by an underground line. Left-hand drive is the rule in Sweden but it has been proposed to alter to right-hand rule of the road. Note also the key position of marshalling yards for Stockholm rail traffic. Main railway routes shown by a heavy line, freight only by a pecked line, minor passenger rail routes by a thin line and "Underground" by a fine dotted line.

Based, by permission, on *Railway Gazette*, London, 5 April, 1940 and various town plans and photographs.

with manufactures. The first industries of any significance were brass-founding and wool-weaving. Between 1636 and 1765 the city had exclusive trading privileges for the Mälar and Norrland regions and grew wealthy in handling all Norrland timber and most of the Bergslag iron. In addition to handling these valuable exports it was the point of intake for most imports. After 1880 the industrial activity increased and, though with a wide range from food-preparation to shipbuilding, specialises in light mechanical and electrical

engineering. Since 1919 manufacturing near the port has been encouraged by the provision of a Free Port which is one of the best equipped in the world; at this sector of the waterfront are imported also coffee, grain, fruit and automobiles. The trade statistics reveal, however, that Stockholm is losing its domination over the exports of Sweden. Despite this the commercial significance of the capital has increased, for the distribution trade over the immediate hinterland has widened at the expense of other centres.

Götaland

Lake Vätter, which occupies a faulted depression on the Småland plateau edge, is the focal point of Götaland, yet separates it into east and west provinces. It is bounded by high, fault-line cliffs on both the east and west, but on the east the cliffs are separated from the lake by a narrow alluvial plain, while the flanks of the ridge are masked by sandy terraces derived from the period when the lake was formerly of greater extent. Except in the north there are few islands in this lake of 740 sq. miles (1,898 sq. km.); the largest island is Visingö in the south. The straight, faulted coastline results in a scarcity of sheltered harbours, and the lake has round its shores few towns with port activities; a further handicap is that approaches from the west are limited by the ridge of Hökensås. The opening of the Göta Canal in 1832 brought new life into the province, although its dimensions were regrettably small. This canal, constructed under the inspiration of Count Platen and with the advice of Thomas Telford, represents an amazing amount of energy—seven million working days—but the work was well executed and no major repairs have ever been required. Not only did the inland areas benefit but the declining port of Söderköping was rejuvenated. On the banks of the canal Motala grew as an engineering centre, using the abundant water-power of Motala-ström, while north of the canal the arsenal of Finspång, founded by de Geer with Walloon workers, increased in significance. Despite this engineering and other industrial activity Östergötland remains above all an agricultural district although few parts approach the yields of the area south of Vadstena. Beyond Skåne the proportion of land tilled exceeds three-quarters of the area only in the plain round Lake Tåker, close to the west shore of Vätter.

The historic province of Östergötland has a varied geological structure, with the granite horst of Omberg (862 ft., 263 m.) and down-faulted Cambro-Silurian rocks in the west, Archæan rocks with an ice-swept surface marked by lakes orientated north-north-west to south-south-east in the south and recent alluvium in the north. The southern massif, an extension of Småland, affords some water-power but offers few resources for agriculture and so is an area

of decreasing rural population. In the Middle Ages the plains of Östergötland played a considerable part in the political evolution of Sweden, with Vadstena as an important ecclesiastical and cultural centre contacting the outer world through Söderköping. Unfortunately this was a frontier zone and it was ravaged by Vitalians in the fourteenth century and by Danes in the sixteenth and early seventeenth centuries. This, coupled with changes in the ecclesiastical domain, resulted in decline, except where urban sites, such as those of Linköping and Norrköping, were in particularly fertile districts or favoured in respect of routeways. In 1782 Norrköping was made one of the three Swedish towns where Jews were allowed to settle and it is now fifth among the textile manufacturing towns of

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FIG. 66.—TYPICAL SWEDISH BARN.

This barn, with ramp approach to hayloft, is alongside the Göta canal but similar barns have been built by Swedish and other settlers in North America.

Sweden. Structurally modern, although of ancient foundation, it has displaced Linköping as a commercial centre. The latter, a natural centre of communications, manufactures road and rail vehicles while still retaining a cultural lead as county town. Norrköping is the fourth largest town in Sweden and owes its importance to its situation 6 miles (10 km.) from the outlet of Motalaström at the head of Bråviken; the estuary gives good harbourage, with quays having as much as 23 ft. (7 m.) of water alongside. The town has a flourishing industrial life with nearly 300 establishments and the manufactures range from wallpaper and rubber to turbines.

Västergötland has its plains orientated towards Väner and the lower course of the Götaälv and so turns away from Östergötland.

It is an area of more maritime climate, with less seasonal contrast, and so oats becomes the chief cereal and there is a considerable cattle industry. Structurally the area consists of fragments of a pre-Cambrian peneplane surface down-faulted along north-north-east to south-south-west faults. On this surface was deposited a mantle of Cambro-Silurian rocks of which only three outcrops remain at Falbygden, Kinnekulle and Halleberg–Hunneberg. Kinnekulle, rising to 1,004 ft. (306 m.) has been preserved by the resistance to erosion of a cap of diabase which has now been largely removed in quarrying. The flanks of the hill have natural terraced slopes and these, with their meadows, fields and woods give an attractive landscape. The limestone outcrops have been extensively quarried and burnt for lime. The glacial features include two great terminal moraines, while the deposits from the Yoldia Sea are represented by a mantle of sand and clay, with forests on the lighter and arable farming on the heavier soils. The land south of the Göta Canal is generally covered with sands and gravels which usually nourish a very poor type of agriculture but round Skara, one of the oldest towns in Sweden, is a cultivated lowland which is, however, not so fertile as the lime-rich glacial soils between Falköping and Skövde. Falköping, an historic town attacked by Danish invaders in the sixteenth century and burnt by fire in the eighteenth, is the centre of the Fal district, cradle of the Gothic culture in Sweden, and rich in pre-historic remains. In the province was promulgated the Västergötland code of laws on which the present Swedish judicial system is partly based. The plains of Västergötland were the first settled region north of Skåne and until the mediæval period it was a zone of wealth and political leadership. To-day the plains have retained the agricultural character which gave their original value and here the dairy industry, particularly for cheese production, is important. Farms are scattered over the plain and forestry and industry are subordinated to agriculture. Many of the ancient market towns were burnt in the wars with Denmark, but are still alive, although industrial development is slight except at Tidaholm, only created a town in 1910, where matches are made and motor-vehicles assembled. But without important industry this region has suffered a decline in the rural population during the present century.

To the west of Väner lies Dalsland which is crossed by sections of the two great terminal moraines of Central Sweden and close to these are fans of stony drifts which form poorer land. Dalsland has been the scene of Swedish-Norwegian wars and, remote from centres of control, was also at the beginning of last century the home of robbers. Western Dalsland, grooved by deep valleys with wooded slopes, had its natural focus at Frederikshall and, with its frontier situation, has

absorbed Norwegian characteristics into the dialect and outlook. To this day roads twist and turn among the western farms, many of which have been deserted because of poor communications and thin soils. The people have drifted to the towns or emigrated to the United States. The Dalsland Canal with the associated Stora Lee–Östen Canal, a slender thread of water opened in 1868, did much to cement this frontier province to Sweden. The canal leaves Väner at Köpmannabro and, by a series of locks, avoids the rapids of the river: at Håverud is a celebrated aqueduct over the river with rail and road bridges adjoining. At first the canal carried iron-ore to the works along its bank but to-day little more than rafts of round timber are transported for navigation is slow; it takes seven hours to pass from Väner to Lelången, with 22 locks to negotiate.

Bohuslän

Bohuslän differs from the rest of Sweden and resembles Norway, to which it belonged until 1645: the sparsity of land routes and the long water frontage of this elongated and narrow province have dominated the economic development. Bohuslän is a continuation, in the form of a horst, of the Östfold granite-gneiss and its rocky surface continues as a skärgård to just south of Göteborg. Across the region runs a network of faults—one component of which is aligned north and south and the other north-east and south-west—and these give the pattern to the fjords and valleys. The rocks of the north are fine-grained granites while those of the south consist of gneiss and porphyry, but all are polished and scraped by the ice. The post-glacial seas deposited thick layers on the floors of the valleys, which were subsequently uplifted, and to these areas settlement has been attracted. The intervening rocky outcrops are bare, having been stripped of morainic material in the process of uplift, carrying but little heath and peat; their only use is for sheep grazing, but the numbers of sheep are small. On the alluvium-covered valleys which are sheltered from salt-laden winds the maritime climate produces a luxuriant vegetation which has been partly cleared for agriculture. Originally many of the islands had oak woodlands but these were burnt during the wars of the seventeenth century when Sweden was struggling to advance her frontier to an ice-free sea in 1645: Särö which still retains much of the woodland cover is a popular tourist resort. As a response to an intricate skärgard and coastline, which provide shelter from wind and sea, there have arisen over seventy fishing communities exploiting the Skagerrak and North Sea fishing grounds. To-day the villages, with their houses presenting gable-ends to the sea, and living by sea-fishing and tourism, are the lineal descendants of the settlements set beside the sheltered waters of

the creeks which were used by the Vikings. The fisheries are varied: herring are caught in winter by trawl and seine-nets, mackerel from August to October by dory-lines and shrimps by trawls. Small boats fish off the Shetland Islands and off Western Norway for ling and mackerel which are salted and dried or otherwise cured. Over

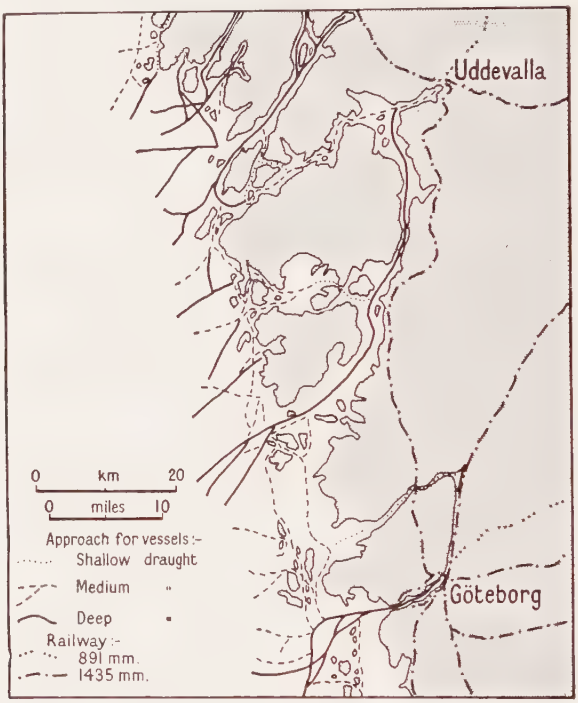

FIG. 67.—APPROACH CHANNELS TO THE WEST COAST.

The many approach channels serving the coast of Bohuslän, together with the sheltered creeks, have encouraged the establishment of fishing harbours. The exceptional assets of Göteborg have prevented the growth of rival commercial harbours. In the post-war years Uddevalla has become an important ship-building centre.

Based on Swedish charts and *Svensk Lots*, Del I, 1941.

half the Swedish catch is landed along this coast from modern fishing vessels. The declining granite industry was well developed round Lysekil and between Hunnebostrand and Idefjord; the working of these handsome, dark granites was encouraged by the regular jointing of the rock and the location of the quarries near deep water. With the growth of the summer tourist traffic added to these other sources

of wealth Bohuslän is more advanced and has been longer and more intensely settled than the apparent barrenness would suggest. During the Norwegian period the town of Marstrand flourished, but it has since declined, although it possesses a big fleet of fishing boats. Uddevalla, on the deepest *vik* of the Swedish coast and within 31 miles (50 km.) of Väner was in 1800 more peopled than Malmö. It has continued to grow and has become the biggest town of the län; it is a centre for commerce and for supplies to the fishing industry, and also makes textiles. Lysekil, a ferry town at the meeting of navigation channels, constructs boats and is the centre for the fish-canning industry of Bohuslän.

The Göta Valley

Running from Väner to the Skagerrak is the Göta älv which carries the drainage of 18,915 sq. miles (48,000 sq. km.). To the north and east is Älvsborg län, which is a district of poor soils with forests covering three-quarters of the area, and yet it is a region of

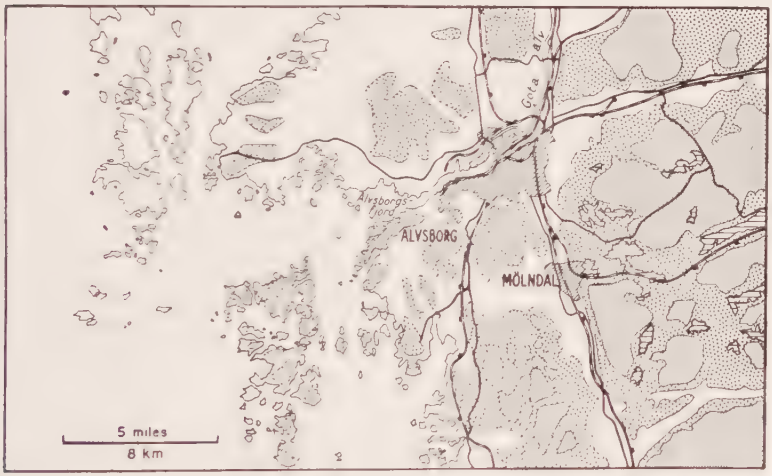

FIG. 68.—LOCATION OF GÖTEBORG.

Göteborg is situated at the lowest bridging point of the Göta älv and is a focus for road and rail. Fine stipple land above 100 m., coarse stipple above 50 m.

Based on Admiralty Charts 129 and 196, Swedish maps, *viz.*, 1:400,000 (Sheet III) and 1:100,000 (Sheets 24, 25, 32 and 33) and K.A.K. road map.

increasing population. At the old town of Borås on the Viska, to the original woollen and cotton textiles manufacture was added that of ready-made clothing and the population increased from 4,723 in 1880 to 67,000 in 1961. Nowadays, the zone of greatest activity

is the Götaälv valley. The river for a period formed part of the frontier between Swedish and Danish territory but even then it was an important highway with portage links upstream from Lilla Edet. As early as the sixteenth century work commenced on a canal and in 1607 a lock at Lilla Edet was brought into use. There is a difference of level of 145 ft. (44·35 m.) between Väner and the sea but, after several abortive attempts, direct navigation was achieved in 1800, by means of the Trollhätte canal. The depth of the lock sills, however, was only $6\frac{1}{4}$ ft. (1·90 m.), so that when the Göta Canal (Väner to the Baltic) was opened there was a pressing need to improve the Trollhätte Canal and new locks were opened in 1844–5 with a sill depth of $9\frac{3}{4}$ ft. (2·97 m.). With the expansion of traffic a third canal was opened in 1916 with a depth of $14\frac{1}{2}$ ft. (4·4 m.) but with a minimum lock sill depth of 18 ft. (5·5 m.) to facilitate future enlargement. Six locks now overcome the difference of level. Roads and railways cross by swing or bascule bridges and it is possible to navigate the 56 miles (90 km.) of waterway throughout the year except for about two months when navigation is liable to be hindered by ice. During the ice-free period, day and night navigation is possible. Improvement of the Trollhätte canal necessitated the deepening of the harbours of Karlstad, Kristinehamn, Åmål and Otterbäcken so that full advantage could be taken of the new asset. Further, the Götaälv has long provided power for industry: a map of 1714 shows some twenty watermills situated alongside the falls. Trollhättan falls, 105 ft. (32 m.) high, are now harnessed to provide hydro-electricity to Göteborg, Borås and Karlstad as well as to the chemical and electro-metallurgical industries of Stallbacka, a part of Trollhättan. At Trollhättan, created a town in 1916, there is a great industry producing cars, aircraft and aero engines.

In 1619 Gustavus II Adolphus established Göteborg, giving it municipal privileges four years later, to replace older communities scattered along the lower course of the Götaälv, among them, Gamla Lödöse and Nya Lödöse, which had been destroyed at various times by the Danes. The King employed Dutch architects to lay out the town and the character they imparted to it through its straight streets and canals still remains. During the succeeding hundred years there was an influx of Dutch, German and Scottish merchants whose descendants still play a prominent part in the commercial life of the city. The eighteenth century saw a flourishing East Indian trade, which led also to the establishment of colonies in the West Indies and North America but prominence came to Göteborg with the continental blockade during the Napoleonic Wars when it was the window for Scandinavia. Increased contact with a wider hinterland followed the opening of canals and railways and led to a further expansion of

trade and population: the latter increased from 26,084 in 1800 to 404,738 in 1961. Trading activity was supported by the fishing industry and the period of colonial interest coincided with that of the maximum importance of Göteborg's herring fishery (1747–1809).

It has a port of considerable magnitude, with $5\frac{3}{4}$ miles ($9\frac{1}{2}$ km.) of developed waterfront and 96 miles (154 km.) of railway sidings, and has become the home-port of the larger Swedish merchant vessels which trade world-wide. The mercantile fleet registered at Göteborg has formed an ever-increasing proportion of the number of the Swedish fleet, and, until recently of an even greater proportion of the net tonnage.

Göteborg registration as a percentage of the Swedish mercantile fleet

	By number of vessels	*By net tonnage*
1865	4·1	14·1
1900	8·2	19·2
1935	12·3	36·5
1959	19·0	31·4 (by G.R.T.)

Commercial growth was encouraged by the creation of a "Free Port" in 1922, and many industries have been attracted in the last hundred years to this centre for Swedish imports. The industrial activity of Göteborg is in fact expanding at a more rapid rate than that of Stockholm. Göteborg manufactures electrical and textile machinery, ships, SKF (AB. Svenska Kullager Fabriken) ball-bearings, calculating-machines, automobiles, pottery, oil and sugar refinery equipment, linen and cotton textiles, foodstuffs and beer. Fed by power from Trollhättan and Lilla Edet stations, there is a succession of industrial establishments in the Gamla Lödöse district producing paper, textiles and glass and at Mölndal, only second to Göteborg although the youngest town in the län, paper and textiles are made and oil is refined.

Embracing the nuclei of the ancient Svea and Göta kingdoms, Central Sweden contains the core of the administrative, commercial and manufacturing activity of the modern kingdom, set in a landscape varied and attractive. Diverse as is the background and different as are the facets, nevertheless this is a region which is bound together by excellent lines of communication and throbs with an industrial life unique in Scandinavia. Excellent as are the resources, their development came from the invention and industrial acumen shown by the Swedish people mingled with that of immigrant Walloons, Dutch, Germans and Scots.

SOUTHERN SWEDEN

South of central Sweden stretches a smaller territory which has well-marked characteristics which are differentiated from the areas further north partly by physical features and partly from Danish influence resulting from its location. The core of this territory is Småland and it is fringed to the west, south and east by limestones and other sedimentary rocks of Silurian or Mesozoic age.

Småland

Småland, sometimes termed the South Swedish Highland, has a peneplaned surface raised by Tertiary earth-movements by some 900 ft. (275 m.). The western edge is a sharp faultline, but to the south a long tongue of upland stretches into Skåne, while in the east the surface dips gently under unconformable Silurian rocks. The peneplane surface, cut on Archæn rocks, has been fretted on the edges but the centre of Småland still gives the appearance of a plateau with modifications brought about by ice-action. Since the region was not submerged under the Yoldia Sea, the sandy moraines have not been re-sorted and lack an admixture of clay which means that the soils are poor. Although altitudes are not great the climate is more severe than in the adjoining plains: snow lies for about 90 days in Småland as compared with 60 at Malmö, spring frosts are more common and the frost-free period is shorter than in Skåne. Precipitation is heavy in the north-west of the upland and leaching of the soils reduces their already poor nutritional content, while between the rocky outcrops, mantled with sandy deposits and a heathy vegetation, peat-bogs occur. Thus the upland has a barrier character which was emphasised by its function as a war-ravaged buffer zone between Denmark and Sweden. To-day the wet areas have been drained, stones cleared off the land to allow tillage, and the soils fertilised, but although it has a pattern of scattered agricultural communities the density of population still remains low.

Fortunately the upland is crossed by a trunk railway and this allowed new life to reach some of the older centres. Once the manufacture of iron was a traditional industry, but this died out at the end of the nineteenth century and bog and lake-ores now accumulate undisturbed on the beds of the lakes. The small towns have a variety of industries—especially the manufacture of paper and pulp, and glass. Glass-manufacturing dates from the founding of the Kosta Glass works, east of Växjö, in 1741, and from the skill here acquired more than a score of other works grew up, of which that of Orrefors is world-famous for its artistic craftsmanship. The traditional capital of Småland, ancient Jönköping, which was founded

in 1284, lies outside the district and is set among the fertile, lacustrine soils of the Vätter plain. Jönköping is on a pre-historic trackway where routes converged to round the southern end of the lake barrier and it still preserves its nodal function. After the foundation of the match-manufacturing industry in 1844 the town acquired an industrial character while its near neighbour, Huskvarna, depending on iron-ore and water-power from the plateau edge, became a centre for producing armaments and hardware.

Skåne

The importance of Skåne is out of all proportion to its area for it is well-favoured: by its position between Scandinavia and the North European plain it commands the Sound, and has fertile soils, gentle relief and, for Sweden, a relatively mild climate. Skåne is a region which geographically belongs to Denmark but, owing to being

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FIG. 69.—HALF-TIMBERED STEADING.

This style of building is found in Skåne and Denmark where there is a shortage of stone and timber. The timber framing is filled in with material such as rubble or clay daub.

separated from that country by the Sound it was possible to incorporate it in 1658 into the Swedish State. Yet even when this was an accomplished fact the culture remained Danish and to this day the long, low farmsteads built of brick, granite or clay are reminiscent of the scene in Sjælland or Pomerania.

The region is crossed by north-west to south-east faults which have produced horst ridges some 160–750 ft. (200–225 m.) high, namely Hallandsås, Söderås, Romeleås, Lindërodsås, Hörjaås and Nävlingeås and these divide the lowland south of the Archæan gneiss plateau into separate plains the character of which varies with the mantle of glacial or marine deposits. Glaciation has influenced soil distribution and while most of the land is fertile, gravel eskers, covered with wood and heath, appear as ribbons of low fertility. Skåne was submerged by the Yoldia Sea and the subsequent uplift has been greatest near Båstad; near Trälleborg, however, there has been recent drowning. River sediments, older than the glacial deposits, have been found by boring to fill a pre-glacial river channel 3 miles (5 km.) wide and named Alnarpsfloden; from the depth of this channel it seems that Skåne must have then been some 215 ft (65 m.) higher than it is now. Skåne is generally a plain but there are modifications: round Skälderviken and Kristianstad the land surface is flat but round Romeleås in the south are low morainic hills which appear still higher as they are tree-clad.

The fault-guided coastline has few islets or embayments except for those eroded out of the Rhætic-Liassic outcrops between the horst ridges. A most conspicuous feature is the great hammerhead spit of Skanör-Falsterbo. Shallow waters extend off-shore and vessels needing a depth of $26\frac{1}{4}$ ft. (8 m.) are unable to round this headland without entering international waters which were mined during the two World Wars. To avoid this danger the Falsterbo Canal, opened in 1940, was quickly cut between Kämpinge and Höllviken with a depth of $23\frac{1}{2}$ ft. (8 m.) and a width of 328 ft. (100 m.) from deepwater to deepwater. Road and rail connection from the watering places of Skanör and Falsterbo is retained by a bascule bridge.

Old maps show that two centuries ago nine-tenths of the area of Skåne were wood, pasture or heath and that the present dominance of tillage results from the agrarian revolution. During the eighteenth century there was a dispersal from the nucleated villages to isolated farms on the holdings, as happened in Denmark. These farms have their buildings enclosing a paved court and the traditional construction was of timber frame filled with clay-daub; with the clay whitewashed and the roof thatched, the farm units set among a tree shelter-belt gave character to the scene. Scattered throughout Skåne are traces, also, of the older rural economy in the large manor-houses. Described as the "Granary of Sweden" the region, all still largely tilled, is turning to livestock with the co-operative system encouraging dairy and pig-rearing interests; as yet Skåne has not progressed so far towards a dominantly livestock

economy as has Denmark. There are minor differences within the region. In the western part of Kristianstad län there is not such a rich soil as in Malmöhus län and so there is less wheat and sugar-beet and more growing of oats, rye and potatoes. Malmöhus län

FIG. 70.—FALSTERBO PENINSULA.

Land in black, coarse stipple under 1 fthm., fine stipple 1 to 2 fthms., pecked line three mile limit. When during the two world wars German minefields were laid up to this limit Swedish vessels, unless of very shallow draught, were unable to round Skåne without leaving territorial waters and so the Falsterbo Canal 23½ ft. deep was cut during World War II. *REV* is a reef.

Based on Swedish chart, No. 132 (1940) and 1:100,000 map, No. 1, 1933.

is the principal Swedish area for sugar-beet and is also outstanding in the production of beet-sugar.

The density of population in Skåne is about 212 to the square mile (81 to the sq. km.), that is approximately the same as the Danish figure while Malmöhus län has 342 to the square mile (132 to the sq. km.). There are many towns but not all are of great significance;

for example, Kristianstad, founded in 1634 as a Danish frontier town, and its outport of Åhus only possess a local value. During the Danish dominion Malmö, acquiring the administrative function previously held by Lund, became only second to Köbenhavn. After the conquest of the south by Sweden Malmö declined and not until the nineteenth century, when the hinterland was enlarged by railways, did Malmö experience a renaissance which led to its becoming the third largest town in Sweden. The port site was naturally inferior to that of Hälsingborg, but has been improved by dredging and quay construction until Malmö is the third port of Sweden with ocean connections as well as the ferry service to nearby København. An inducement to the establishment of industry was the opening of an extra-territorial Free Port in 1922. At Malmö is Kockums Shipyard, one of the most important in Scandinavia: a measure of its capacity was the completion in 1941 of six submarines and twenty motor torpedo-boats.

Malmöhus län has raw materials which have given rise to some industrial activity. The first records of coal-mining in Skåne relate to the sixteenth century and coal, Rhætic-Liassic in age, is still worked in the hinterland of Hälsingborg. At Limhamn and Lomma, near Malmö, refractory and other clays, in conjunction with chalk, have resulted in important earthenware and cement industries. With excellent port facilities for importing raw materials to supplement local produce, Malmö and its neighbourhood have factories for the weaving of cotton and woollen textiles, the preparation of leather, the refining of oil, the manufacture of soap and margarine and brewing. Other towns which have played a part in the evolution of Skåne are Trälleborg, outport for Germany with a train-ferry service since 1909, Ystad, a former Hanse town and until 1868 a packet-port, Landskrona, an old town with a natural harbour little developed, and Hälsingborg. The last, one of the most ancient towns of Sweden, has grown more than its Danish *vis-à-vis* Helsingør and has acquired a variety of industries. During the war it was the escape point for a large number of Danes as the short sea-crossing made it relatively easy to avoid the vigilance of German guards.

Halland

Halland is a long, narrow district entirely distinct from the adjoining Bohuslän. South of Kungsbacka the coast changes character with the disappearance of the north–south faults. All the valleys from the Småland upland are aligned from north-east–south-west and open on to the low alluvial plain formed of fertile clays set between wooded outcrops of granite. The plain attains 9 miles (15 km.) in width but is locally much narrower. The rivers of

Småland cross the fault-line edge to the western lowland in falls which have been used for hydro-electric power: the greatest producing units are on the Laga near Knäred. The availability of power has encouraged the manufacture of textiles. The agriculture of the plain resembles that of Skåne with its emphasis on wheat, oats and fodder; on the edge of the plateau the fields merge into woods, peat and heath. The holdings in size and type are similar to those of Skåne. Climatically this region is one with Skåne for the beech reaches as far north as Kungsbacka and appears to be advancing into the pine area. The coast is frequently dune-fringed, and being smooth without natural anchorages, has few fishing centres except those for catching river salmon. The regional ports are Varberg, Falkenberg and Halmstad and these import grain and export timber, flour, dairy produce and livestock, much of the last two items having been produced with imported feeding-stuffs. Metallurgical industry has grown at Halmstad, which town octupled its population in the hundred years after 1860.

Blekinge

Blekinge, which was part of a Danish province until 1658, separates the Kalmar coastlands from Skåne. The coast is articulated with many natural harbours and its immediate hinterland, although smoother and more extensive, resembles that of the Kalmar plain. The small rivers from Småland have waterfalls, not developed for hydro-electricity, at the margin of the plateau. The region also resembles Skåne in having industrial activity as well as a rich agriculture. Ronneby is the main commercial centre, but its port has deteriorated. Karlskrona, selected for a naval dockyard in 1679 owing to its magnificent protected anchorage, has been since then the chief Swedish naval base. The town is situated on an island without water and so is dependent upon an aqueduct bringing water from the mainland. The port only freezes about one year in three and can be kept open by ice-breakers.

Kalmar coastland

The Kalmar coast is characterised by the outcrop of Silurian rocks. The coasts are straight and lack the forested skärgård of the granite coasts to the north. These limestone rocks and the overlying patches of recent deposits favour arable farming. In the mediæval period this was the most southerly part of the west Baltic shore not controlled by Denmark and so trade flourished so long as the coast served as an outlet for Sweden. Its importance has now declined and even the historic ecclesiastical town of Kalmar has little but local activity even

taking into account the trade with Öland and Gotland, though it is the biggest port of south-east Sweden. It is situated at the narrowest part of Kalmar Sund, where only 2·9 nautical miles (5·5 km.) separates Öland from the mainland. The slight precipitation—less than 16 in. (400 mm.) at Kalmar—is a useful asset to the holiday industry. The district of Möre has a fertility approaching that of Skåne and it is important for growing sugar-beet.

Thus southern Sweden, locally favoured as regards soils and climate, has an active agriculture combined with a more modern industrial interest. Superimposed on this economy is the commercial value of the situation in the frontier zone between Scandinavia and the European Plain and the advantages obtained from the improvement of communication facilities. Since the westward advance of Swedish power to an ice-free sea, the south has had a significance it did not possess while Denmark controlled both sides of the Sound.

THE ISLANDS OF ÖLAND AND GOTLAND

Lying in the Baltic, these two islands close to Sweden are sufficiently large to possess a life of their own, although Öland is administratively part of Kalmar län. Both have a plateau surface sloping towards the east and both have a long axis north-north-east to south-south-west. In Öland the plateau only rises to 165 ft. (50 m.), about 100 ft. (30 m.) below that of Gotland.

Öland

Although the island of Öland is 85 miles (136 km.) long it is only 4–10 miles (6–16 km.) wide and is an outcrop of limestone and slate almost parallel with the Kalmar coast. Narrow as is the sound at Kalmar the sea connections are severed in severe winters by ice forming on the brackish water, with no appreciable tides. The centre of the island is bare and arid with a steppe-like vegetation which grows along the joints on the limestone where soil and moisture can collect. Along the edges of the island are sandy deposits of Ancylus and Littorina age at the foot of the west-facing limestone rampart. This island has long been inhabited, as witness the relics of a Stone Age fisherfolk. To-day it is relatively densely peopled although the area of good soil is limited to the beet-growing district behind Mörbylånga. The houses and farms are built round courtyards and, with the shortage of timber, limestone slabs are used for building and fencing. Formerly on this windswept surface there were many windmills but as they fell out of repair they became disused. The limestone is cut and polished, as well as being burnt for lime, and provides a major source of revenue, while many of the

young men spend some years in merchant ships and so bring money to the impoverished island. The assembly point of the products is Borgholm which, dominated by the ruins of a large castle, has become a watering place.

Gotland

Gotland, which is 77 miles (125 km.) long, has a maximum breadth of 31 miles (50 km.) and so is much larger than Öland. The basal rocks are fertile marls which have attracted settlement, while the central outcrop is a resistant Silurian limestone which lacks surface water, except in the shallow, clay-floored valleys, and presents a karst appearance (*alvar*) with, on the coast, limestone stacks known as *raukar*. Morainic clays, rich in lime because they are derived from Silurian marls, modify the surface while Ancylus Lake deposits are found up to 130 ft. (40 m.) in the north and up to half that height in the south, and Littorina Sea deposits up to 82 ft. (25 m.) and 50 ft. (15 m.) respectively. Despite its limestone core about one-tenth of the area was bog on account of the clay deposits and the gentle slopes giving only a slight run-off. There are patches of pine-woods; more than half the area is covered with thin woodlands and the bold, steep limestone cliffs of the west have a rim of conifers, but the growth is characterised by the short trunks and big heads of trees resulting from poor soils and the coldness and dryness of the spring and early summer. The island is an agricultural area and with its mild climate it produces butter, meat, market produce and flowers for the Stockholm market only a few hours away by steamship. The sand-covered isle of Fårö, which marks the end of the treacherous Salvo reef, is used for sheep grazing. In the endeavour to increase the farmed land marshes were drained but this unfortunately reduced the moisture content of adjacent arable lands and crops suffered without providing good pasturelands from the former marshes.

Gotland was formerly very prosperous, with international trade connections. Visby, "town of the roses and the ruins", was one of the principal cities used by the Hanse traders, but even before this Gotland, with its stepping-stone location, had in the second century A.D. attracted traders between the east and the west. The town is situated in a hollow which breaks the barrier edge of the limestone. Selected by German traders in the middle of the twelfth century, it became the maritime node of the Baltic but its decline was inevitable when the Crusaders opened new routeways in the Middle East and when the Mongol conquests resulted in the exclusion of European commerce from Russia. Its wealth was legendary and after being attacked by pirates several times it met its commercial doom in 1361 when ravaged by the Danish King Valdemar Atterdag.

Passing successively under the control of the German Order of the Vitalie Brotherhood, Lübeck and the Danes it became Swedish again only with the Treaty of Brömsebro in 1645. Even after this Treaty the island was occupied by the Danes in 1676–9, who destroyed its fortifications, and by the Russians in 1808. Since then Visby, unique among Swedish cities in its setting and colouring, has acted merely as the centre for Gotland and traded with Nynäshamn for Stockholm. Despite, or perhaps because of, its ancient foundation, Visby still maintains a vigorous life and its 15,000 inhabitants do not depend solely on tourism. The resources of the island are limited; there is a tradition that the stalwart Gotlanders, in whose blood ran that of pirates, were not above praying for wrecks, so that they could obtain booty. The modern industries are the manufacture of bricks and cement at Slite.

CHAPTER 9

DENMARK

54°34′–57°45′ N.
8°05′–15°12′ E.

In 1939 Denmark comprised an area of 16,576 sq. miles (42,932 sq. km.), that is, one-third of the area of England. The kingdom consists of the peninsula of Jylland (Jutland), several large and some hundreds of small islands of which about one hundred are inhabited. These islands are all close to each other and to Jylland except for Bornholm and Ertholme which lie some six hours steaming distance eastward from København. After the Schleswig Plebiscite the land frontier with Germany was only 42 miles (67·6 km.) long.

Lacking much of the modern drama of Finland as regards frontier changes, the Danish Kingdom has had nevertheless several metamorphoses since its formation in the eighth century. Across the narrow waters of the Sound control oscillated between the Danes and the Swedes whilst the Hanseatic League also endeavoured to control these waters from its centre at Lübeck. German people pressed into Schleswig-Holstein and in 1864 these duchies were annexed by Prussia, only to be recovered, in part, in 1920. Thus Denmark had contracted greatly from the dominion of Canute and Valdemar, and its capital of København (Copenhagen) had changed in location from a central to a frontier city looking across narrow waters to the former Danish provinces of southern Sweden.

GEOLOGY AND RELIEF

With the exception of the rocky island of Bornholm, which is mainly formed of igneous rocks of Pre-Cambrian age, Denmark owes most of its physical features to the effects of glacial deposition. Only rarely does the pre-glacial floor of chalk appear on the surface. The story of the glacial period is complicated not only by the advance and retreat of ice but also by changing land and sea-levels and by changing climates. In the geography of Denmark the significance of the Ice Age is so constantly apparent that it is almost impossible to over-emphasise this feature of the geomorphological history. The landscape is largely moulded from morainic material which consists of unsorted masses of debris deposited by the ice sheets; the

surface of such terrain varies from very slightly undulating to very hummocky, according to the position and movement of the ice-sheet at the time of deposition. Re-advance of the ice-sheets moulded the

FIG. 71.—GEOMORPHOLOGICAL FEATURES OF DENMARK.

1. Dune landscape
2. Recent marine foreland
3. Late glacial raised sea-floor
4. Young morainic landscape
5. Eskers
6. Ice-lake landscape with plateau hills
7. Valleys cut by meltwaters
8. Outwash plain
9. Old morainic landscape
10. Granite landscape

Based, by permission, on (Edit.) N. Nielsen, *Atlas over Danmark*, Pt. 1, København, 1949.

older morainic drift into elongated drumlins with their long axes parallel to the direction of the fresh advance of the ice-sheet. In places where the moraine was laid down along with dead-ice the

ground surface resulting is broken, with many kettle-holes which may appear as lakes or boggy areas.

On the site of the lakes formed in and against the ice-sheets, the morainic surface is masked by a lacustrine layer which is frequently worked for brick clay. With the melting of the ice-masses, great volumes of water were produced and these could flow near the margin but within the body of the ice; the beds of these streams became coated with sediment and, when the ice sheet finally vanished, trails of sediment were occasionally left as long ridges or eskers, winding across the landscape independently of the underlying relief forms. Where the ice halted temporarily in its retreat, the rivers streaming from it laid down great aprons of fluvio-glacial deposits which to-day form smooth surfaces known as outwash plains; the greatest examples of these are the Karup, Grindsted and Tinglev Hedesletter immediately to the west of the position of maximum extent of the last advance of the ice. If these meltwaters flowed from the margin of an ice-sheet a normal longitudinal valley profile resulted, but if they flowed under pressure beneath the ice, over-deepening could occur and with the melting-away of the ice, the resultant valley has an irregular longitudinal profile; this type is known from its mode of origin as a tunnel-valley. Many such tunnel-valleys occur in eastern Jylland.

After the last retreat of the ice-sheet the relative level of the sea with respect to the land fluctuated, and marginal areas were submerged more than once, but the net result has been a general uplift and the rivers have produced newer generations of valleys set within the wider, and now higher, floodplains of the earlier stages. This normal river valley development is also eliminating morainic features, particularly in western Jylland where the last advance of the ice failed to cover the older moraine. Another feature helping to obliterate the older forms is their burial by sand-dunes. Again this is most apparent in western Jylland where dune formation is favoured by strong west winds and a higher tidal range (5 ft. or 1·5 m.) than in the east; on this very gently shelving shore a wide expanse of sand is exposed at low water and is carried inland by the wind as moving dunes. The dune fringe extends almost unbroken for 190 miles (300 km.) from Skallingen to Skagen and limits the possibility of coastal settlements; in the south the dunes are fragmented by submergence.

The coastal landforms of Denmark include types not frequently found in the rest of Scandinavia. Although the land near the sea is generally low, the lack of resistance to erosion, and the tendency for the clays to slip constantly provides fresh material for marine action and young forms of cliff are being constantly created. Uplift

of the land leaves behind raised beaches, and "fossil" cliffs are found far inland in northern Jylland. There is a tendency for the coast to be smoothed as islands are joined to the mainland by sandspits and bays disappear. In the eastern part of the archipelago and in northern Jylland chalk outcrops and forms cliffs, which by virtue of fractures and the presence of interbedded clays frequently present broken fronts to the sea and, in general, are eroding more rapidly than the chalk cliffs of south-eastern England.

The low, sandy North Sea shore of Denmark is marked by features characteristic of emergence, with sandspits and dunes cutting off several wide lagoons from the sea. South of Esbjerg, however, the last phase was one of submergence and the dune fringe, enlarged by westerly gales, has been broken into islands which are a continuation of the North Friesian groups of Germany. Occasionally along this shallow coast submerged trenches, resulting from the rush of water from the melting ice, provide access to the ports like Esbjerg. The Baltic shore, in contrast, is one of submergence, with many shallow bays. The headlands, mainly formed by glacial deposits but occasionally consisting of chalk cliffs, enclose bays which are termed fjords by the Danes but, of course, beyond being long and providing access to the interior, bear no resemblance to the fjords of Norway. Extensive areas, aggregating some 130 sq. miles (330 sq. km.) have been reclaimed from the shallow bays along the Danish coast. By contrast with most of the Baltic coast of Denmark that of Bornholm is straight and owes its origin to faulting.

CLIMATE

Climatically, Denmark displays a mixture of maritime and continental features, having conditions more continental than Norway and more maritime than Sweden. With a seaboard not greatly tempered by the drift of warm water across the North Atlantic, the maritime influence is not so marked as in Britain; the temperature range is greater and the precipitation less. The climate differs from that of Scotland less in the nature of the seasons than in the rapidity of the seasonal change: autumn and spring are very short. The Baltic Sea, less salt than the North Sea, and of small extent compared with the East European plain, has but a slight ameliorating effect. The weather varies according as to whether western or eastern influences are dominant; the former brings moist and the latter dry conditions. The low relief and small area of Denmark mean that there are no great regional differences; though the west tends to be wetter and the east colder in winter. The growing season is limited by the liability to frost which, away from the

coast, is likely to occur from September to May. The frost-free period varies from 150 to 225 days according to the location and site.

Precipitation occurs throughout the year from cyclonic depressions with, in addition, convectional rain in summer resulting in an August maximum. The precipitation decreases northwards and eastwards from South Jylland but of course there are local deviations from this generalisation, due to relief. In the sandy districts the wet years are the best for crop growing, provided it is dry and sunny in the ripening period. The number of rainy days (over 0·1 mm. of precipitation) is similar to that experienced in southern England, for example 156 at Herning. Fog is a serious menace, particularly in winter, for with the gently shelving shore vessels can run aground before they are in sight or sound of lighthouses and countless have been the shipwrecks and the tales of wreckers along the western coast of Jylland. Along the west coast also is a zone, up to 30 miles (48 km.) inland, liable to crop damage from a salt mist. On the other side of the peninsula, Ålborg experiences a cold dry wind, known as *skai*, in early summer which can be very destructive to crops. The extensive tile-draining which has been done in the last hundred years removes the cold groundwater from the upper layers of the soil and allows of earlier work on the land in the spring.

SOILS AND VEGETATION

Because of the short period of time which has elapsed since the last of the glacial periods, the soils developed on the glacial deposits have a close relationship with the parent material. The poorest soils, of a podsol type, are found on the older deposits of the west which are the most sandy and much leached by the heavier precipitation. Eastward, inside the later moraines, the soils rapidly improve until in east Jylland and the archipelago clay loams are found; these are rarely podsolised and are classified by some pedologists as belonging to the humid brown soil-group. In a soil survey conducted by the Danish Heath Society two-thirds of the land examined in Jylland was discovered to be lime deficient, compared with one-third in the islands.

Before man interfered there was a close relationship between the soils and the natural vegetation but it is probable that much of what was regarded as indigenous heathland in Jylland was, before 1000 A.D., forest-clad and that a considerable proportion of the 3,500 square miles (8,065 sq. km.) of waste was man-made. It is known, for example, that in the peninsula of Røsnæs in Sjælland, there was a hunting forest until in 1231 Valdemar II caused all trees to be removed on account of the accidental shooting of his heir by a huntsman.

There has long been considerable discussion on this point, for it was realised that for reclamation to be successful the new cover must be adapted to the ecological conditions and ecologists and soil scientists have examined the problem of the heathland for a considerable period. Dalgas believed that the heaths of Jylland were on an area once wooded; Sarauw, from the hardpan, concluded that it had for long been an area of *Calluna* heath while P. E. Müller thought that the hardpan had formed under tundra conditions and that the tundra had therefore been displaced by heath. The conflict of views, coupled with Jonassen's pollen analysis[1] seems to indicate that since the Sub-Atlantic period when oak-woods covered the area there

FIG. 72.—DUNE FARM NORTH OF ESBJERG.

This is a traditional farm building in the dune area along the west coast of Jylland. In the background is a barn with the thatched roof continuing from the ridge to the ground.

had been a constant struggle between heath and forest, with the heath only recently victorious.

The dunes of the west carry, when they are fixed naturally, low creeping plants such as willow and a wild binding grass (*Calamagrostis* sp.) which gradually provide a closer sward, but the dunes are now being planted with marram grass. The sandy uplands were formerly marked by ling (*Calluna* sp.), heath (*Erica* sp.) bilberry and dwarf willows, but many of the heaths have now lost their original character by being reclaimed for forestry and farming. In some of the sandy areas heath has been converted to grassland by irrigation. Situated on the floors of the misfit stream valleys in the wetter areas are damp marshes which have been much reclaimed for pasture by

[1] H. Jonassen; Et pollendiagram fra Karupfladen, *Botanisk Tidsskrift*, Bd. 43, Hefte 3, 1935, pp. 187-96.

draining and marling. The wettest areas of all carry peat bogs; these have been much reduced in area by artificial drainage but nevertheless it is estimated, after survey, that there are over 120 million tons of peat (mostly in Jylland) which can be cut for fuel and the land subsequently reclaimed. On the heavier clay loams forest, dominated by oak and beech, was indigenous and it was the clearance of these forests for fuel, building and shipbuilding, which freed the land for agriculture. About three centuries ago oak and ash were the chief trees in the Danish archipelago but since then, possibly encouraged by selective cutting of oak, they have become rare and beech is the dominant tree in the natural woodland. These old natural forests (known as *skov*) contrast with the plantations (known as *plantage*) which contain exotic conifers, such as Norway spruce, silver fir, larch, *Pinus montana* and Scots pine, the only indigenous conifer in the mainland area being juniper. To-day the Danish Heath Society is still encouraging the planting of trees, particularly in shelter-belts at right-angles to the prevailing wind, in order to reduce the loss of soil by wind-erosion which can be acute in the sandy terrain of Jylland.

POPULATION

Man appears to have first entered Denmark when the Ancylus uplift united the Scandinavian area. Round the fresh-water Ancylus lake roamed the elk, but not the reindeer, in the woods of *Pinus sylvestris*, mixed with alder and oak. There primitive Palæolithic man lived close to the lakes and subsisted by fishing and hunting (the "Mullerup" culture). As the Ancylus period closed, early Neolithic man entered and began to form his kitchen middens of shells (the "Ertebölle" culture) round the shores, especially those of the Lim fjord which was then more saline than it is to-day. After the Littorina depression the rise of land was continuous in northern Jylland and occupation of freshly exposed land areas was a feature of the Bronze Age settlement. Living in the favourable sub-Boreal climatic period, agriculturists and pastoralists were able to replace the fishing and hunting community so that dependence upon agriculture came early and persisted despite a later deterioration of climate.

The people of Denmark have a fair colouring, but they tend to be less blonde, shorter and less long-headed than the inhabitants of Norway and Sweden. As with all nationalities there are considerable variations, partly due to prehistoric flows of people and partly to historic, such as the influx of Huguenots or of Scots adventurers. Many Scots mercenaries were hired by Christian II from his uncle

James III of Scotland, husband of Princess Margaret of Denmark: Scottingade in Ålborg adjoins the site of barracks erected to house the Scots Guard of the period. In south-west Jylland there is a considerable admixture of Friesians and Germans.

Denmark is characterised by the presence of a great middle-class community. Few relics of the feudal nobility remain, feudal servitude having been abolished in 1788, while at the other end of the social scale there are few paupers. This development has been aided by the predominance of owner-occupiers in the agricultural system and by the fact that even the owners of large estates take an active part in the running of the land.

As with all these northern countries, the Kingdom suffered severely from bad seasons and plagues. In one Danish duchy alone 100,000 persons are said to have perished in a series of disasters and this was little compensated for by what now appears to be the exceptional cheapness of food. In the sunless summer of 1349, the Black Plague, said to have come from a wrecked ship, destroyed more than one-third of the population of Jylland, and the Ale Mose district, which had been settled, reverted to moorland and was not reclaimed again for over five hundred years. In the present century the standard of living has been high with the cost of food, in 1939, about three-quarters of the level in Britain, and this offset the fact that the annual income for over three-quarters of the population was under 3,000 kr. (£165); cf. 7,812 kr. (£404) in 1957.

The Danish population totalled 4·6 millions in 1960, that is less than half the population of Greater London. While the density averages only some 276 persons per sq. mile (106 persons per sq. km.) it is the most densely peopled of the Scandinavian countries. Vahl showed that the greatest density of the agricultural population occurred in the archipelago and in eastern Jylland, where there were the best agricultural soils; there were subsidiary centres of greater density on the boulder clay soils round Lim Fjord and on the late glacial marine clays of Vendsyssel. The concentration is increased by the fact that it is just where farming is most flourishing that there are most artisans, while in the poorer, sandy districts the farmers do many repair jobs themselves. Vahl also pointed out that in the areas of larger farms the population density is less than in the districts with similar soils but with small agricultural holdings. The population includes units of foreign-born people and of these Swedes and Germans are the most considerable. For many years, prior to the economic depression, there used to be a considerable summer and autumn influx of Polish boys and women to help with cultivating and lifting sugar-beet in Lolland-Falster; it used to be regarded as impossible to cultivate this exacting crop without their labour.

Of the minorities, only the Germans have given rise to a modern political problem and this has been largely because the land frontier to the south enclosed enclaves of both nationalities. Schleswig-Holstein was torn away from Danish control as a result of the war of 1864. Prussia was eager to obtain full control of the access to the Baltic and before the end of the nineteenth century the opening of the Kiel Canal (1895) and the Prussian fortification of Heligoland had placed shackles on Denmark as Bismarck wished. A policy of Germanisation was pursued in the territories of Lauenburg, Holstein and Schleswig, but Danish outlook persisted and predominated in part of Schleswig and the plebiscite of 1920 returned North Slesvig (Schleswig) to Denmark. It was re-named Sonderjylland (South Jutland), and there has been an effort to bring it back to Danish ways of life and at the same time to re-orientate the economic life upon Hadersley since the natural centre of Flensburg remains in German hands.

AGRICULTURE

Although endowed with hungry soils and a climate with hard winters and short summers, Denmark has developed her agriculture as an important industry. Before the war the resemblance to industry was very real in that the fertilisers and feeding-stuffs were imported and the produce was exported after being processed on the farms. From the start of the break-up of the open-field system in 1769, the law prevented the formation of large estates and instead created a peasant-proprietorship, and this control was increased after a Commission of Enquiry which met in 1786. One eighteenth-century enactment forbade the division of holdings below a size sufficient to maintain a family; this was necessary as, with no law of primogeniture, land tended to be divided equally among the children. The land-hunger

FIG. 73.—AASLEV, NEAR SLAGELSE IN SJÆLLAND IN 1768.

The black strips indicate the land farmed by one man from his house in the village. The division between the three fields is indicated by a pecked line.

Based, by permission, on G. Hatt, *op. cit.*

which still remained unsatisfied after the enclosure period was partly met by the formation of *Det Danske Hedeselskab* (the Danish Heath Society), in 1866, which aided the reclamation of land by drainage, marling and planting of trees in the attempt to restore the equivalent of the land area lost to Germany. Inspiration for this reclamation came from E. Dalgas whose writings, such as *Engvanding i de Jydske Heder* (Aarhus, 1866) brought its possibilities to the notice of the Danish people. Water-meadows have also been created in order to increase the output of hay, for example those fed from the Store Skjernå canal in Jylland. The results of the activities of the Society are impressive, for apart from keeping industrious people on the land, the 2·4 million acres (0·97 million ha.) of moor in 1866 were halved by 1896 and by 1940 only totalled 0·5 million acres (0·20 million ha.), and it is expected that in another generation the only heathlands will be in nature reserves. However, whilst there has been this reclamation of land for agriculture, especially in west Jylland and Himmerland, there has been in this century a reduction in the cultivated area in the islands and in east Jylland, largely owing to the demands of the expanding urban centres.

As a result of the Napoleonic wars, and of the increasing industrial population of Britain, the Danes at first began to concentrate upon the export of grain. But the prosperity which came from this was short-lived, for the grasslands of Russia and North America became exporters and flooded the market with grain at prices lower than the Danish costs of production. Similarly the beef cattle trade which was substituted, collapsed under falling prices as the New World entered the market for meat supply. In place of these activities, the Danes in the 1880s introduced the dairy and bacon industries using cheap imported feeding stuffs and chemical fertilisers to improve their own yields of fodder crops. This led to phenomenal production, but made the producers dependent upon the supply of these raw materials and so were particularly vulnerable to world conditions. Instead of laying the land down to grass, as in Britain, arable farming was maintained in Denmark; except for the shortness of the summer, the climatic conditions are more favourable to cropping than in most parts of England, and the grain and roots produced (including sugar-beet waste) were fed to livestock. Crop yields are greatly increased by the careful use of the dung and liquid manure in a way which surpasses British technique. The crops of Denmark are particularly well suited for fodder; for example, most of the winter wheat, too soft for bread, is used for livestock feeding. To get as much feeding value as possible much of the grassland is part of a long-term rotation similar to that of Scotland.

An interesting development, taking advantage of the habitat, has

affected the growing of potatoes. This crop is said to have been introduced into west Jylland in the late eighteenth century as part of an import of foodstuffs to relieve a famine. Poor, sandy soils and a bleak climate are the physical conditions where the bulk of Danish seed potatoes are grown. Only healthy and vigorous plants can thrive under such conditions, for diseased plants flag quickly and can easily be "rogued".[1] Furthermore the occurrence of green-fly and other pests, including the virus diseases, is reduced to a minimum, and finally, the dreaded Colorado beetle has not yet appeared in Denmark. Potatoes from such a grudging habitat flourish when transplanted to other places. Maintenance of quality and breeding of new varieties is encouraged by governmental control. Export takes place in the autumn and spring, but by the construction of a large frost-free warehouse at Esbjerg, with equipment to allow potatoes to be loaded during frost, it is hoped to be able to ship throughout the winter. Exports of seed and ware potatoes go to South America and Israel as well as to western Europe.

After the introduction of the centrifugal cream separator in 1878, it became possible to establish central creameries and most of these were, from the beginning in 1882, co-operatively owned by the supplying farmers. The skim milk, apart from a proportion kept for cheese making, is returned to the farms to be added to barley and used for pig-fattening, and the production of fat pigs has become firmly associated with the dairy industry. Co-operative slaughter-houses were created, the first in 1887, and these have laid down rigorous standards as to the dimensions and weight of carcases. Unlike the co-operative efforts in Britain, the Danish concerns are financed by borrowing, and not by share issues, and the individual members are liable for the financial debts of the concern. It is indicative of their soundness that no such undertaking has failed.

As an example of the response to changing markets, the fat pig industry may be taken. From the Middle Ages until the nineteenth century live pigs were driven from Jylland to the trading centres of Lübeck and Hamburg where they were slaughtered, largely for salt pork for use on ships. The Free Trade policy and industrialisation of Great Britain in the nineteenth century opened a new market for Danish produce and the weekly sailing from København to Newcastle (introduced in 1870), and the opening of the Esbjerg to Harwich run (1875) added to the opportunities for entering the British market. For a period Danish bacon was sold so cheaply that during a British election campaign one political party gave bacon free to its

[1] Potatoes being grown for seed are examined while growing and plants showing haulms not true to variety or not healthy are destroyed.

supporters. There was a major switch in 1895 away from the German market, which demanded large, well-fattened pigs, to the British which required meaty, leaner pigs and to produce this type Large White Yorkshire boars were imported to cross with the Danish Landrace breed and so provide the suitable carcase. The standards were so carefully maintained that the pigs had almost the uniformity of a factory product when received for slaughtering.

Expansion of the market in Britain was helped by sending bulk cargoes from Esbjerg to Parkeston Quay (Harwich) and with the quantities involved it was possible to negotiate in 1895–6 rates which were usually lower than those which prevailed for East Anglian produce shipped to the London market. Without the low rates

Freight rates per ton for agricultural produce, 1896

	Esbjerg to London	*Local rates Parkeston Quay to London*
	s. d.	*s. d.*
Butter . .	25 0	16 8
Bacon . .	18 0	18 9
Meat . .	28 6	30 10
Eggs . .	32 6	21 8
Fish . .	20 0	23 5

which mechanised transport permitted Danish agriculture could not have evolved as an intensive system.[1]

Until 1933 the British market was apparently assured, but in that year the United Kingdom imposed a quota system and it was necessary to limit the production of pigs for bacon. The farmers were allowed to place any number of pigs on the market but they only received adequate prices for those which were covered by a "pig-card"; the rest had to be sold at a price which did not cover the cost of production. The pig-cards could be bought and sold between the farmers, and if prices for these cards were high then the pigs were sold for home consumption as pork.

Using the Red Danish cow as the basis of the milk industry there have been considerable technical advances. Moreover, when grazing the cows are tethered by ropes long enough to allow them just sufficient to eat and this saves the green fodder from being wasted by trampling. The advantages include even manuring and avoiding the expense of fencing or the waste of land by hedges but

[1] For an account of the transport factor see V. E. Lundsfryd, Transport af Landbrugsprodukter, *Den Tekniske Forenings Tidsskrift*, Jan. 1932, pp. 1–70.

the pegs have to be moved frequently and the animals must also be watered. Tethered animals are also unable to seek shelter from the elements. At the end of September or in October the cows are brought into winter quarters and have to be kept there for over six months, on account of the severity of the winters; thus Denmark is not so favoured as the south-western districts of England. Jylland formerly used to be famous for its fine, dun-coloured horses with black tails and manes; these are high-stepping and were once popular for private carriages; no longer, in this mechanical age, are they bred for export.

As a result of the intensive efforts both quality and quantity of the produce have risen; apart from horses, only sheep numbers fell considerably in the inter-war years and this was due to the removal of so much of their heathland grazing. The numbers of all livestock fell appreciably during the Second World War and recovery has been handicapped by the shortage of feeding stuffs. Whilst most of the economy is based on dairy cattle and pigs there has been a valuable increase in the output of eggs, and Denmark was until 1939 the world's biggest exporter of eggs; in 1960 about one-quarter of the British egg import was of Danish origin. There is no "poultry district" in Denmark and the birds are fairly evenly dispersed throughout the country, although there is a denser distribution in the archipelago, for the smaller farm units have the largest number of hens per acre. As with other livestock the improved output is due to keeping more productive breeds as a result of careful recording of results and breeding from selected strains.

Yields per acre, both of livestock and crops, are high compared with British standards and some of this difference must be attributed to the large number of owner-occupiers (about 95 per cent of the total holdings, ranging from the largest to the smallest units), who treat their land and stock with great care. Credit must also be given to the spread of modern technique through the encouragement of the State and the Agricultural Institutes, and to the control exercised by the co-operative creameries and slaughterhouses over the quality of produce handled by them.

The farm holdings range from 25 to 250 acres (10-100 ha.). The farms are run as family concerns and any labourers are on an equal social footing with the owners. Small-holdings are those below 25 acres (10 ha.) and are worked from a cottage. The owners of small-holdings have fewer mechanical aids so the work is disproportionately greater than on the farms. The provision of owner-occupier small-holdings was made possible by heavy financial aid from the State which was justified on the grounds of keeping people on the land and increased output. This last effect is seen in the

results of surveys of part of the Province of Randers; before and after the provision of small-holdings the livestock kept in one district were:[1]

Changes in livestock numbers, 1902–8

	Horses	*Cows*	*Young Cattle*	*Sheep*	*Pigs*
1902	9	210	7	71	192
1908	80	295	98	22	300

Even more than the farmer the smallholder takes part in co-operative buying and selling. The sons of both groups frequently work as farm labourers before acquiring a holding of their own and this helps to prevent the creation of a social bar between the larger and smaller holders.

The large Danish farms differ from most of the Norwegian and Swedish (outside Skåne) in that the buildings are grouped round a court; only in the small holdings is the human and animal accommodation under one roof-tree.

During the last hundred and fifty years there has been a movement of the farmhouses away from a village unit to the centre of the holding resulting from the consolidation by the State or large landowners of the arable land worked by a farmer. In 1682 nine out of every ten rural dwellings were in villages, and round the villages—set in a sea of grass or of wood (or in western Jylland of heath)—were the cultivated fields wherein the land worked by any one farmer occupied scattered strips. Only in the regions of poorer soil in western Jylland and Bornholm were there, from the beginning, scattered farms. As well as villages there were small towns, many of ancient foundation, and existing by the thirteenth century as trading centres, perhaps protected by a castle. Both villages and towns have now either become decayed or else have been rejuvenated by industry and so have changed their original function.

Since most of the rural people are farmers the density of settlement varies closely with the quality of the soil; the density is least on the sandy tracts of west Jylland and greatest on the clay loams of the east. The only outstanding exception to this generalisation is the concentration of people round the transport nodes of the ports and railway junctions. Marryat, writing in the pre-railway period, vividly describes the traditional site of towns: "Never trouble yourself to enquire where or how a town in Jutland or one of the duchies be situated; take it for granted, if on the coast, snugly nestled at the

[1] H. R. Haggard, *Rural Denmark and its lessons*, London, 1911, p. 312.

extreme end of the fiorde; if inland, on the banks of some deep-watered lake, surrounded in either case by woods—such woods as we read of in Shakespeare."[1] Denmark, despite heavy emigration, experienced the same considerable increase of population in the late nineteenth century as did most of north-western Europe, but because of the emphasis on agriculture it was not accompanied by rural depopulation until the period of economic depression between the two world wars. A considerable increase of rural population occurred between 1870 and 1880, when there were nation-wide efforts to reclaim land, although at the same time certain towns grew rapidly with the improvement of transport and the rise of industry.

Many of the provincial towns were late in experiencing an increase of population, as the following table shows. In almost every case growth of any magnitude has resulted from improved communications: the most dramatic example is that of Esbjerg which in 1868, the year the harbour was started, had a population of about 30, in 1870, 460 and by 1901, 13,355.

Population of selected larger provincial towns

	1769	1801	1834	1935	1950 (*incdg. suburbs*)	1959 (*incdg. suburbs*)
Odense . .	5,464	5,782	8,709	76,116	100,946	120,525
Århus . .	3,837	4,102	6,765	90,898	116,167	165,522
Ålborg . .	4,425	5,579	7,048	55,280	79,806	111,726
Randers . .	2,901	4,562	6,407	30,254	40,098	53,314
Fredericia . .	2,813	3,474	4,141	21,463	25,981	27,910
Horsens . .	2,738	2,393	4,826	29,856	35,898	38,720
Roskilde . .	1,711	1,768	2,828	16,104	26,335	29,556
Kolding . .	1,510	1,872	2,309	23,520	31,017	34,211
Vejle . .	957	1,310	2,409	24,354	29,448	37,619
Esbjerg . .	?	20	23	30,714	48,205	52,877

[Based on J. Humlum, Befolkningstilvæksten i den 10 Største Danske Provinsbyer *Det Danske Marked*, 3 Hefte 1942; and Statistisk Årbog, 1952, Table 9, etc.]

MANUFACTURING

Unlike conditions prevailing in Britain the chief industrial units of Denmark, other than those of Köbenhavn, are closely bound to the agriculture both in the site of the factory units and in the supply of raw materials. There is however the same clash of interests as is to be found in other semi-urbanized countries such as New Zealand, between the agricultural community, who wish to buy manufactures

[1] H. Marryat, *A residence in Jutland, the Danish Isles, and Copenhagen*, London, Vol. I, p. 90.

cheaply, and the urban who wish to buy foodstuffs cheaply and are antagonistic to subsidies aiding agricultural exports. Lacking great fuel, mineral and timber resources the main industries have been connected with agriculture and the sea.

Dependent upon agriculture are the processing industries for butter, cheese, bacon and beet-sugar manufacture, while to meet the requirements of the primary industry there is a considerable manufacture of farm equipment. As a result of the need for oil-cake for feeding purposes oil-seed pressing mills of considerable capacity handle soya beans, ground nuts and palm kernels. The oil is used for margarine which, ironically, often replaces butter in the diet of the Danish population. Originally there was a considerable woollen manufacturing industry, but with the decimation of the flocks between 1871 and 1938 cotton became the chief textile made. Leather preparation remains a noteworthy industry but the production of hides is considerably greater than their consumption in Denmark and so the surplus is exported. As a by-product of the livestock slaughtering there is a bio-chemical industry producing insulin, hormones, vaccines and other pharmaceutical preparations as well as dried blood and bone meal for agriculture. The growing of poppies for the production of morphine and codeine was tried but planting had ceased by 1938. While the Danish pharmaceutical industry prepares barbituric acid derivatives there are no works distilling coal-tar and so acetyl salicylic acid (annual consumption 75 tons) and phenacetin (16 tons) have to be imported. The relatively small home market means that large foreign companies can import into Denmark at lower prices than these materials could be produced in Denmark. Apart from supplying some of the requirements of sawn timber and insulation board one further industrial value of the conifer plantations has been the extraction, from the needles of *Pinus montana*, of pharmaceutical oils. Pit-props are cut for export but the total quantity is negligible compared with that of Sweden.

With a close interest in maritime life the Danes, despite the lack of raw materials, have created an appreciable shipbuilding industry at København and Odense and specialise in diesel-engine construction for both marine and land use. In 1911 the firm of Burmeister and Wain, of København, built the *Selandia*, the first ocean-going motorship and in 1948 there was launched from this yard the *Thorshövdi*, 23,500 tons d.w., a floating whale-factory and the largest ship till then built in Scandinavia.[1] The merchant fleet of Denmark plays an important part in the life of the country and the fleet is modern and motor-driven. Besides the vital coastal routes their merchant navy, sometimes in association with British and

[1] In 1954 a vessel of 30,000 tons was launched from a shipyard in Stavanger.

Swedish companies, trades world-wide. Most of the home terminals are on the Baltic seaboard, near the richer parts of Denmark and with better sea approaches to the ports than are found in western Jylland.

Without much mineral wealth the Danish chemical industries are handicapped in their development. The vast home demand has created a chemical fertiliser industry using phosphate rock imported from North Africa. The Greenland cryolite mine is responsible for a cryolite refining plant at Kobenhavn and the refined product, 99·7 per cent pure, is used in aluminium smelting, in the enamelling of iron and steel and for making "milk" glass. The aluminium industry consumes three-fifths of the cryolite production, metal hollow-ware enamelling one-third and the remainder for making this cloudy glass. Chalk is Denmark's most valuable mineral substance and it is used as a building stone, in the manufacture of Portland cement and for lime. Flint, a vital material to Stone Age man, is still worked in Denmark; the flint is now dug by machines from wet pits and washed and the best flints are then picked out by hand and shipped from such creeks as Stroby and Haarbolle. Many thousands of tons are used for porcelain while flint pebbles are used in grinding mills where steel balls would add impurities. The presence of limestone and of glacial and other clays has resulted in the establishment of a large cement and sand-lime brick manufacture although it is handicapped by fuel shortage. The Mo Clay (Lower Eocene) contains nodules of diatomaceous material cemented with lime and these nodules have been collected for the manufacture of Portland cement and for refractory bricks. Granites and Cambrian rocks from Bornholm have been utilised in Denmark or exported to Germany as building stones; the other principal source of mineral building material comprises glacial erratics of Norwegian and Swedish origin. From 1794, when a surge of agricultural improvement commenced, stones were cleared from the fields in the boulder clay areas of Jylland and used for stone walls round the fields, but these walls have now been removed for constructing farm roads. This supply was, however, inadequate and in 1931, which may be taken as a representative year, 40,000 tons of paving stone and 70,000 tons of road metal were brought from Bornholm; most of it went to the archipelago and southern Jylland. In the same year a further 100,000 tons of paving stone and 80,000 tons of road metal were imported from Sweden.

FISHERIES

With a coastline long in proportion to its area (there is one mile of coast for each 5¾ miles of land), and with surrounding shallow seas

rich in fish, it is natural that the Danes should be a fishing nation. The fisheries are based on the sale of fresh fish for direct consumption and only small quantities, about one-fifth of the total catch, are industrially processed. In recent years Denmark has followed world trends and the production of processed, ready-for-use, fish

A.C.O.] [*April, 1953*

FIG. 74.—FISHING CRAFT AT HVIDESUNDE.

This place was created as a fishing harbour about 1935. Ringkøbing fjord used to drain out at Nymindegab but this exit was closed by a gale and in 1910 a fresh outlet was made at Hvidesunde. Later there was a re-opening of the gap to the north.

products such as quick-frozen plaice and cod fillets, canned "sardines" (sprat or brisling), herring and mackerel fillets, fish-balls and shrimps (in aluminium cans) has been rising rapidly. Following the trend in Scandinavia the consumption of salt herring has declined while that of processed products has increased rapidly, especially in the urban areas.

COMMERCE

Trade in Denmark was first developed by the Hanseatic League, particularly by merchants of the City of Lübeck, and when that

trading organisation collapsed in the sixteenth century the site of København, dominating the Sound, ensured that Denmark controlled the trade of the Baltic. Besides exporting home-produced livestock from the then greater area of Denmark, Danish merchants also carried traffic for the Baltic countries. Prosperity continued to increase until the Napoleonic wars destroyed the mercantile fleet. When trade revived after the middle of last century it was with a new emphasis on the import of the raw materials of agriculture—feeding-stuffs and fertilisers—coal and metals and the export of dairy produce and machinery. The former links with Germany were gradually broken down and no longer was colonial produce purchased in Hamburg. Under the pressure of the economic depression of the inter-war years agreements were made with other countries and by one of these Denmark was guaranteed 62 per cent of the import of bacon into Britain and 38 per cent of the egg import. In return for these supplies, as well as specified quantities of butter and fish, Britain was allowed to provide four-fifths of the coal imports of Denmark.

With limited resources, Denmark has a commercial activity above the average for her population or for the area of useful land and has established important trade connections particularly with Britain, Germany, Sweden and Norway. Exports were less in value than imports but the balance of payments was met by the earnings of the mercantile fleet and by interest on loans abroad. To supply the engineering industry coal and iron and steel imports were essential and more than half the cost of these was met by sales of machinery and ships abroad. In view of the intensive feeding of livestock, Denmark was unable to grow sufficient grain and needed considerable imports of rye, maize and oil-seeds (mainly processed at Århus) and also fertilisers to improve the home yield of grain and fodder. Exports were dominated by agricultural products, for nearly three-quarters of the 1938 value of exports was due to agriculture; the principal consumers were Britain and Germany. Industrialisation reduced the agricultural percentage to 55 by 1960.

REGIONS OF DENMARK

Denmark has a great variety of landscapes, although almost all are so closely dependent upon deposition from ice-sheets that regional differences are not dramatic. The following provide a useful basis for regional study:

The Mainland
- West Jylland (Jutland).
- North Jylland.
- East Jylland.

The Danish Archipelago { Fyn (Fünen). Sjælland (Zealand). Lolland and Falster.

Bornholm.

THE MAINLAND

Jylland has a great variety of physiographic forms, with an apparent medley of hills, hummocks, valleys, depressions and plains resulting from the ice-sheet and its meltwater rivers. The last advance of the ice only reached as far south and west as Holstebro and Bording but even so the extreme limit was only reached for a short period and the main stationary line was north and east near Karup and south to Vejle. Beyond this main halt-line solifluction and sub-ærial erosion have for the most part levelled the surface.

West Jylland

This is the area west and south of the maximum extent of the most recent glaciation. Small hills of older glacial material rise out of a sandy fluvio-glacial plain, but the hills have been much eroded or smoothed according to the local conditions of sub-ærial action and to the nature of the material. Set among the broken country are open valleys still showing signs of the misfit character of the rivers by the many patches of wet bottom or shallow lakes. The plains which surround these hills are formed of fluvio-glacial sands and gravels laid down by the great flows of water which left them with a gently sloping surface; the present streams tend to be but slightly entrenched and also have wet land alongside the running water. Along the south-west coast there are marine deposits of sands and clays formed in the Littorina Sea. The whole coastline is bordered by dunes which, unless anchored by planting, tend to move inland. In the south the invasion of the North Sea has broken the chain of dunes into an archipelago but the island of Rømø has been joined to the mainland by a causeway and this operation is creating, by silting, new marshland which can later be reclaimed.

The hills are formed of sands which weather to a yellowish soil formed of leached sand with a low clay content; but since it contains some clay at least, it is rather more fertile than that of the sandy outwash plain. A feature of the soil profile is the presence of a hard-pan which marks the concentration of ferruginous material but this can now be broken by a deep tractor plough and the knife harrow, whereas once it had to be dug out by hand. Despite the incredibly great quantities of marl applied during reclamation, the soils remain

light, and in years of slight rainfall crops are prone to fail. On the sandy outwash plains which are still under heath and on the undrained marshes, the population density is low, but it increases as reclamation proceeds. It has more than quadrupled since 1801, and this is due to the vigorous reclamation of land since 1870. In 1860 there were in Jylland 808 sq. miles (2,093 sq. km.) of heather moor, 72 sq. miles (186 sq. km.) of bog and 40 sq. miles (104 sq. km.) of barren sands which were reduced by 1896 to 252 sq. miles (653 sq. km.) of heather and bog and 30 sq. miles (78 sq. km.) of sandhills. Between the two world wars the districts of poorest soil showed a decrease of population although the region as a whole still shows an increase. With poor soils, a moist climate and strong winds, the land may be most profitably laid down to grass (which grows verdantly) for cattle rearing; thus the agricultural population density can never approach that of the richer areas. Cattle rearing is aided by the long frost-free period, which is about 200 days near the coast and gives a longer period of grass growth than in most of Denmark. Some of the reclaimed land however is used for the cultivation of rye and mixed grain; mixed grain (barley, oats, peas and vetches) returns a heavier crop than if the constituents are sown separately, and the oats and barley hold up the creeping peas and vetches. There is considerable cultivation of potatoes for fodder, for seed and for industrial purposes, including the manufacture of starch, alcohol and potato flour. In the last century bands of Germans came into western Jylland to help with the haymaking and harvest and they moved about the countryside in small bands like the Irish workers in England.

Nucleated settlements are few, for the original occupation was by scattered farms. In this region the buildings are made of bricks, and so contrast with the older buildings of the better areas of the east where tree growth allowed timber-framed structures. Few towns exist and all are transport nodes. Esbjerg has the distinction of being the only valuable port on the west coast of Jylland, although there are several small fishing harbours, and even it had to be artificially created when Tønning, in southern Slesvig, which had previously acted as the port for the region, was lost to Prussia in 1864. The site was selected on account of firm land without impeding dunes and the presence of an off-shore trough which could be readily dredged. Further assets were the shelter given by Fanø and the fact that it lay on the direct line between København and southern England and so could act as a packet port; before 1864 the creek of Hjerting had been used for shipping beef cattle to England. The export traffic of Esbjerg has increased steadily since its foundation, save only during the periods of war and economic turmoil. Most of

the export trade is in foodstuffs, for which tonnages in representative years are:

1900 . .	89,156 tons
1925 . .	224,398 „
1932 . .	454,819 „
1952 . .	112,780 „

The import traffic is greater than the export, and it too has increased many times since the railway was opened in 1874; imports in 1874 totalled only 11,000 tons, in 1938, 385,000 tons and in 1959 693,000 tons. To-day the town has acquired fishing and other industries because of the port facilities it offers. Oligocene clay is used here and at Holstebro for earthenware manufacture. The working of amber, which had been gathered on the shore, was a traditional activity at islands such as Fanø. Other centres of population are Tønder, Ribe, Varde, Herning and Holstebro and all these have grown as railway junctions with the reclamation of the heathland after 1870. Viborg, which lies to the north-east of the region, was the historic capital of Jylland but with the rise of other towns now plays but a small part in the economy of the west.

North Jylland

The northern part of Jylland is underlain by chalk which is folded into a great syncline with a north-west–south-east axis. This chalk is exposed in the vast quarries of Ålborg and alongside Mariager Fjord. The last ice-sheet, in its rapid retreat, left terminal moraines with low-lying undulating land between them. It is believed that the ice which came from the north reached Jylland before the ice-margin advancing from the south but that it melted away more quickly and thus northern Jylland was opened to the flow of melt-water across Lim Fjord district. After the Third Danish glacial period part of the region was submerged and marine clays were laid down; the subsequent uplift was followed by a further period of submergence and deposition of marine deposits of a sandy-clay character. Marine sands are blown inland by strong winds: in 1757 a violent storm almost buried the church of Gammel Skagen situated on the sandy northern peninsula. The lake of Sjørring, drained in 1860, was once an inlet from the North Sea but it was cut off from the salt water by the formation of sand dunes, whilst the nearby church of Torup, centre of a rich district, was also overwhelmed by sand.

Marryat[1] gives a vivid description of the scenery of the wilder parts of Jylland: ". . . those wide-extending mysterious plains typical of North Jutland. Picture to yourself a raging sea, all wave and

[1] *Op cit.*, Vol. II, pp. 77–8.

battle, ferment and locomotion, suddenly stilled by the magic wand of a magician, to stay as it is now, never to move again, but become after a time, like stagnant water, covered with duckweed, green, later black from the decomposition of vegetable matter. Such is the country we this evening drove through, wearisome to a degree, still not uninteresting: patches of corn, patches of heath, black soil, white sand, a curious irregular colouring not often witnessed in nature. Even the endless tumuli give a certain variety to the scene, standing detached, as they always do, against the horizon: some black, others green; one has been just flayed, for its turf's sake, or may be for its heather, manufactured by the women into brooms and carried to Ålborg market." This district used to be a great horse-breeding area and Randers, on the border with eastern Jylland, once had a great horse-fair. Apart from wild game, only geese and tethered sheep flourished in the moorland tracts, such as Store Vildmose. The State purchased 6,716 acres (2,800 ha.) of this moor in 1920 and by 1928 2,964 acres (1,200 ha.) had been turned from heather and sphagnum to grassland by drainage and marling.

With a landscape bleak and monotonous: yet with a melancholy charm, and with a poor, sandy loam, a windswept surface and a comparatively short growing period of 150 days, agriculture is limited. Wind-power used to be exploited by windmills for milling and for pumping water, but wind-pumps for drainage are not now required, as with mechanical equipment drains and water courses can be lowered along their whole length. This has accelerated the natural effect of uplift of the land and to this day many of the villages are situated on slight eminences above what were formerly bogs and lakes; many resemblances can be seen to Fenland geomorphology and settlement. The main crops grown are oats and rye for fodder for cattle rearing. Where the soil is better and contains more clay, as around the town of Hjørring and on the island of Mors, the density of population is greater. The district of Ty has a limestone substratum and, although fertile and with few peat bogs, suffers from drought.

While the increase of population since 1801 has been considerable there has not been such a great increase as in western Jylland, where there was a more vigorous reclamation of waste land. All the larger centres are ports, with the exceptions of Hjörring and Brönderslev. The twin towns of Ålborg—Nørre-Sundby straddle the narrowest part of Lim fjord and form the second port of Jylland, serving the important vegetable oil and cement industries. The manufacture of cement results from the presence of pure limestone (up to 99·6 per cent pure calcium carbonate), and suitable "plastic clays" (Lower Eocene) alongside Lim and Mariager fjords. Formerly a train ferry

was used to cross Lim fjord but this has long been replaced by a swing bridge. Although a channel exists through to the west coast it is winding and shallow; from the evidence of raised oyster-beds it has apparently become shallower with continued uplift of the land, and now only the eastern entrance is used by large vessels. The Agger Channel (Thyborøn Kanal) was reopened naturally by the removal of a sand-dune during a violent storm in 1825 with a depth of 8 ft. (2·4 m.) but it silted up again during the mild winters of 1858–9 and became of little use. While Ålborg has lost much of its political value—before 1814 it served as the main port between the joint kingdom of Norway and Denmark—it still remains an important route focus and commercial port. The minor port of Fredrikshavn is on an open site, which has necessitated the construction of substantial breakwaters but, although conveniently situated for services to southern Norway and to Göteborg, it has not maintained its trade. Several centres are used for the North Sea and Skagerrak fisheries for herring, mackerel, plaice and shrimps while there is an extensive fishing industry, particularly for eels, in Lim fjord.

East Jylland

This is a region of younger relief where glacial landforms, besides being fresher, present a greater variety of scenery, with terminal moraines, fluvio-glacial outwash plains, tunnel valleys and other features in close proximity. The tunnel valleys which converge near Silkeborg and Viborg show that lobes of ice from Norway and from Sweden met in this district. At a later stage of retreat the moraines in Djursland curved round to the east, indicating a stillstand of the Swedish ice-stream pressing from the south; with open water appearing over what is now north Jylland. The general grain of the country is east and west along the alignment of the tunnel valleys and their associated fjords, but in the Djursland district the north and south ice grooving is revealed by the alignment of Kalø andÆbeltoft bays. The depressions, many of which were originally cut by water working under the ice-sheet, are steep-sided and occupied by lakes or peat bogs little touched by man. Generally the region has an attractive appearance compared with that of Northern Jylland: north of Vejle runs the inset valley of the Greis which, pretentiously described as the Danish Switzerland, retains an attractive vegetation and character which has been lost on the adjoining reclaimed plain.

The soil developed on the ground moraine of the Swedish ice-sheet is a blue-grey clay with a high clay-particle and lime content; it is reddish brown in colour and among the most fertile of the soils of Denmark for wheat and potato cultivation. It extends as a belt some 20 miles (30 km.) wide along the seaboard of east Jylland.

Djursland peninsula is the only district of poorer quality, for the soils, developed on terminal moraine and outwash deposits, have a smaller clay content and the relief is more hummocky. In east Jylland generally the land is used for arable farming with pasture in the valleys, and stands of beech and oak give character to the landscape. Farms are isolated and their buildings are grouped in a square with an air of massive prosperity. Molesworth, writing of Jylland in 1692, pertinently commented: "This is a plentiful Country, abounding more especially in Cattle; it wants good Sea-Ports towards the Ocean, notwithstanding which the *Hollanders* [i.e. the Friesians] transport yearly great quantities of lean Cows and Oxen from hence to their more Fertile Soil, where in a short time they grow so prodigiously fat, through better feeding, in the rich Grounds of Holland."[1] Only near the harbours could there be, in the past, real contact with the metropolis.

Since 1801 the population has quadrupled but this is mainly due to the development of the towns whose growth was encouraged by the rich agriculture and by the establishment of industry. The important urban centres are all ports situated on re-entrants from the sea and so are well placed to ship the products of the region. Århus, the second largest urban unit of Denmark, situated on a wide bay, protected by the promontory of Djursland, is one of the historic towns of Denmark which has been rejuvenated. The port has been greatly extended in recent years; the protected water area has been quadrupled (to 138 acres, 56 ha.), the length of quayage nearly trebled (to 4⅓ miles, 7·0 km.) and the depth of water increased from 24 ft. (7·5 m.) to 33 ft. (10 m.) since this century began. The enlargement of the port works has been encouraged by the comparatively easy sea approaches. Århus has a site which was naturally ill-drained and so the town, often visited by strangers, was said to be the first in mediæval Denmark to be attacked by cholera or typhus. To-day the town has vegetable oil and light engineering works and owes much of its value to its position as the focus of the most fertile areas of Jylland.

Fredericia was formerly a rail-ferry point for crossing to Fyn but now the crossing of the Lille Bælt (Little Belt) is made on a rail and road bridge, opened in 1935, which reduced the train crossing time from 15 minutes to 45 seconds. Construction of the bridge was difficult as the maximum depth of water in the channel was 133 ft. (40 m.) and the sea-bed was uneven. The town of Silkeborg offers an epitome of the changing vigour of life which surged up in Denmark during the nineteenth century. In 1846, when it was a dreary waste, uncultivated and uninhabited, the site, beside a lake and the waters

[1] Molesworth, *op cit.*, p. 22.

of the Gudenaa, the longest Danish river, was selected for a rag-paper manufactory and within fourteen years there were 1,400 people there. For a period, before the railway connection was opened in 1871, the town was served from the port of Randers by barge traffic on the Gudenaa.

DANISH ARCHIPELAGO

In their retreat the ice sheets left low plains of boulder clay between gravelly terminal moraines. The ice sheet thrusting northwards excavated three large hollows which now appear as straits in the archipelago. On the islands of Sjælland and Fyn the glacial waters near the margins of the ice-sheets laid down eskers whereas in Jylland the meltwaters cut deep into the underlying moraine; why there is this difference has not been resolved. Rarely are the plains very flat and they generally have slightly undulating, well-drained surfaces.

The reddish-brown clay loams are of high agricultural value and are mainly responsible for this being the main wheat area of Denmark. On these soils sugar-beet is cultivated and here are found most of the sugar-beet factories of Denmark, once dependent upon "beet-railways". By contrast, most of the recent extension of sugar-beet cultivation into Jylland has been of a different strain, used for fodder purposes. The islands generally are marked by village development and by the existence of signs of a long-continued occupation of a prosperous land—castles and manor houses.

Along the coast, villages and towns are engaged in the fishing and ferrying industries. Throughout human occupancy of Denmark the unifying factor has been the penetration of the sea which even to this day gives to the archipelago and the adjoining shore of Jylland a method of communication more intimate and more effective than the land routes. Many find the summer climate of the archipelago milder and not so bracing as that of Jylland.

Fyn (*Funen*)

This island contains some of the best agricultural land and so the average size of the farms is the smallest in Denmark. The land is divided into small fields, and with its fruit trees and orchards resembles Calvados. Except on the less fertile soils of the sandy, morainic hills, known as Fynske Alper (the Funen Alps), the density of population is high and there is little land not cultivated; by Danish standards the railway network was close. The major town of the island is Odense. Although situated inland, Odense is linked to the sea by a canal which provides a valuable waterfront for saw mills and

other industries. The town is set in a low plain and is the nodal point in the communication pattern of Fyn.

Sjælland (Zealand)

The relief of Sjælland is not flat for across the undulating plain, formed from ground moraine, run in sinuous shape long ridges of sandy eskers and north–south terminal moraines. The fertile clay loams of the morainic plains maintain intensively farmed fields, and Sjælland has a high density of population. Except for the urban development of the Köbenhavn district on the one hand and the sparsely settled beech-clad sandy district inland from the coast between the capital and Helsingör, on the other, the island is uniformly peopled. Since 1801 the population has increased nearly five-fold but this is mainly due to the growth of Köbenhavn. The rural districts, as in the rest of the archipelago, nearly all showed a decrease of population between the two world wars and this must be attributed to the fall in agricultural prices.

København contained 919,341 persons in 1961, i.e. 22 per cent of the population of Denmark, compared with 10 per cent in 1769. The dominion of the country by København is accentuated by the absence of any other large city, and the lack of balance in the proportion of the capital to the total population is similar to that of Vienna to Austria after the Treaty of Versailles. The next largest town in Denmark, and the only other with a university, is Århus with a population of only 119,186 in 1961. Apart from the ports there are few towns in Sjælland and the largest of these is Roskilde, the mediæval capital, whose cathedral is the ancient burial place of the Kings of Denmark: but this town has relapsed into a local centre only.

København (*Merchant's Haven*) has grown up as the chief city and port of Denmark at the southern end of the Sound (Öresund), at a firm site which lies on a through route between Jylland and the Swedish province of Skåne, and alongside the widest and deepest of the three natural entrances to the Baltic. The port works originated in the sheltered waters of the channel between the islands of Sjælland and Amager and there has proved to be sufficient waterfront for expansion and to allow of an adjoining outer port with deep water for ocean-going craft. The port activities were stimulated by the creation of a large "Free Port" area which encouraged entrepôt and manufacturing activities.

The site of København first became important in 1167 when it was fortified, and it was made a city in 1254. With ferry and trading activities it out-distanced the former capital, Roskilde, and was selected as the centre for Hanseatic trade. The opening of the Baltic

trade in the thirteenth century resulted in increased activity, for the Sound is the least confused of the three entrances to this inland sea. After the collapse of the Hanseatic merchant league, the city acquired further commercial importance; this was the foundation of its modern supremacy and caused the spread from the original nucleus on to the adjoining parts of Sjælland and Amager. This islet of

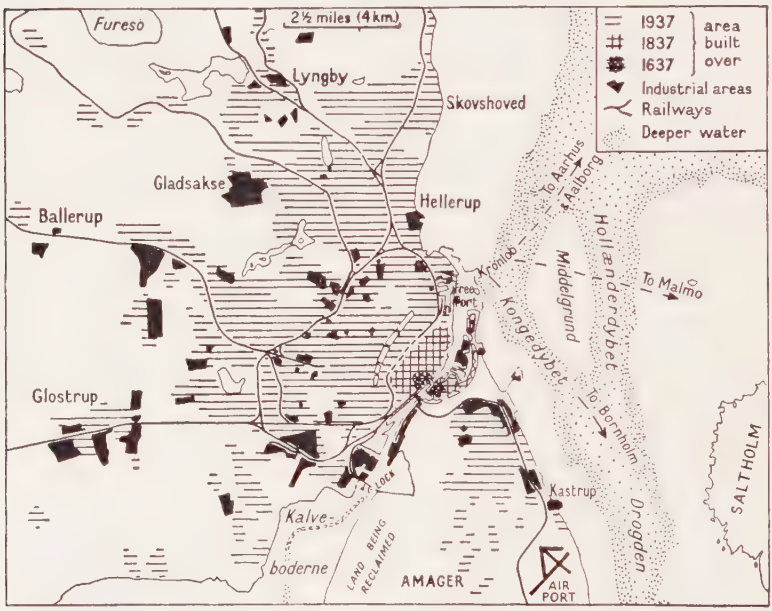


FIG. 75.—KØBENHAVN.

From the tiny nucleus in an *enceinte* between Amager and Sjælland the city has spread widely during the last hundred years. Land has been reclaimed along the waterfront for harbour and industrial premises. The Kronløb channel provides the deep-water entrance. The Free Port, created in 1894, is in the northern part of the now extensive harbour works. Traffic has greatly increased in this century; in 1900 3·3 million tons of shipping and 2·7 million tons of freight were handled whereas in 1959 it was 15·3 and 7·8 million tons respectively.

Based on old maps of Copenhagen (e.g., that published by the Society for the Propagation of Useful Knowledge), København Turistkort, etc.

Amager had been colonised in 1516 by Dutch settlers from Friesland, brought into Denmark by the king to encourage horticulture in the country. It was feared that the importance of the command of the Baltic entrance would be impaired by the opening of the Kiel Canal but the effect has not been so disastrous as was expected. The length of quayage is, to some extent, a measure of the significance of a port and in this respect København is the major Scandinavian port.

Length of Quays

	'000 *yd.*	'000 *m.*
Hamburg . .	34	11·1
København .	33	10·8
Stockholm . .	20	6·6
Oslo . . .	13	4·3
Göteborg . .	12	4·0
Gydnia . .	12	4·0
Malmö . .	9	3·0

To-day the city ranks as the chief industrial, commercial, port and administrative unit of Denmark and as one of the great cities of Scandinavia.

København has a much better port site than the other ferry port and shipbuilding town at the northern end of the Sound, Helsingör (Elsinore), which grew up round the castle constructed to enforce payment of the dues on shipping passing through the channel which here is only 3 miles (5 km.) wide; the payment was later extracted at København. It flourishes however as a tourist centre for it is "sacred to the memory of Hamlet, who, if he ever existed at all, lived somewhere else about a thousand years before it [Kronberg castle] was built".[1] Nearby is the village of Hellebæk where, in the seventeenth century, a German colony was established, using primitive water-power to manufacture small-arms.

Korsør, situated on a peninsula where the Great Belt is narrowest, was once the capital of a province and, becoming disfranchised, fell into deep decay until the completion of the railway from København, in 1856, resulted in a vigorous re-awakening. To-day this town handles farm produce and builds small wooden ships and, besides taking train ferry traffic, the port serves as a distribution centre for foreign goods to minor Danish harbours.

Lolland and Falster

These flat islands have the richest soils of Denmark but owing to their peripheral position have not developed activities other than agriculture. A good example of the attention to detail which has helped to make Danish enterprise profitable is found near the Nykøbing beet-sugar factory where an appreciable area of swampy land has been reclaimed by pumping on to it the mud obtained from washing the sugar-beet. This carries on a long tradition of reclamation, for in 1870 the state granted a concession for the reclamation of

[1] Haggard, *op. cit.*, p. 108.

12,000 acres (4,860 ha.) of swamp at Bøtø, Falster, and it was recovered from the sea by embankment and pumping. The flat land of Lolland is divided into square fields but has rows of pollarded willows and poplars in place of hedges.

Lolland has a sad record of plague, pestilence and famine after its settlement by Wends from the heathen isle of Rügen. In the pest year of 1565 alone many thousands died in the two islands of Lolland and Falster.

The creation of the train-ferry service *via* Gedser has not, as yet, resulted in the development of settlements along its route as happened with some of the towns along the København–Esbjerg route. Since 1937 Falster has been connected with Sjælland by the Storstrøm rail bridge which was intended to accelerate the service between Denmark and Germany by Warnemünde: since the war the service has run to Grossenbrode in the British zone of Germany. This Storstrøm bridge, over $2\frac{1}{4}$ miles ($3\frac{1}{2}$ km.) long, is the longest over-water bridge in Europe.

Bornholm

This island, Fenno-scandian in its geological character, has been Danish since 1522, except for a short period of Swedish control in the seventeenth century. The island is formed by a horst of Pre-Cambrian granite with an apron of Palæozoic and Mesozoic rocks on the southern side. This granite area "is Swedish in its character, the ground undulating, the hills and dales strewn with purple rocks and boulders, tossed about and rising on all sides in the most chaotic confusion".[1] This distinction in geology from the rest of Denmark has resulted in several mineral industries, and in the encouragement of tourist traffic. The granite has been considerably quarried for setts and building stone, the Cambrian rocks for building and monumental stone, while the kaolin is dug for earthenware and faience manufacture; the Jurassic coal deposits, although sulphurous, have been mined. Glaciation has affected the islands but the deposits are thin and irregular. On the poor sands which overlie part of the granite conifers have been extensively planted. The greatest agricultural activity is on the sedimentary rocks; for centuries the fields have been carefully tended with all stones painstakingly removed.

On Bornholm are four of the round churches for which the island is celebrated: they served as fortresses in time of need. Unlike the rest of Denmark there are no *herregaard* (manor houses), for the feudal system never took root. The only town of any size is the capital Rønne but there are several minor ports on the east and north

[1] Marryat, *op. cit.*, Vol. II, p. 353.

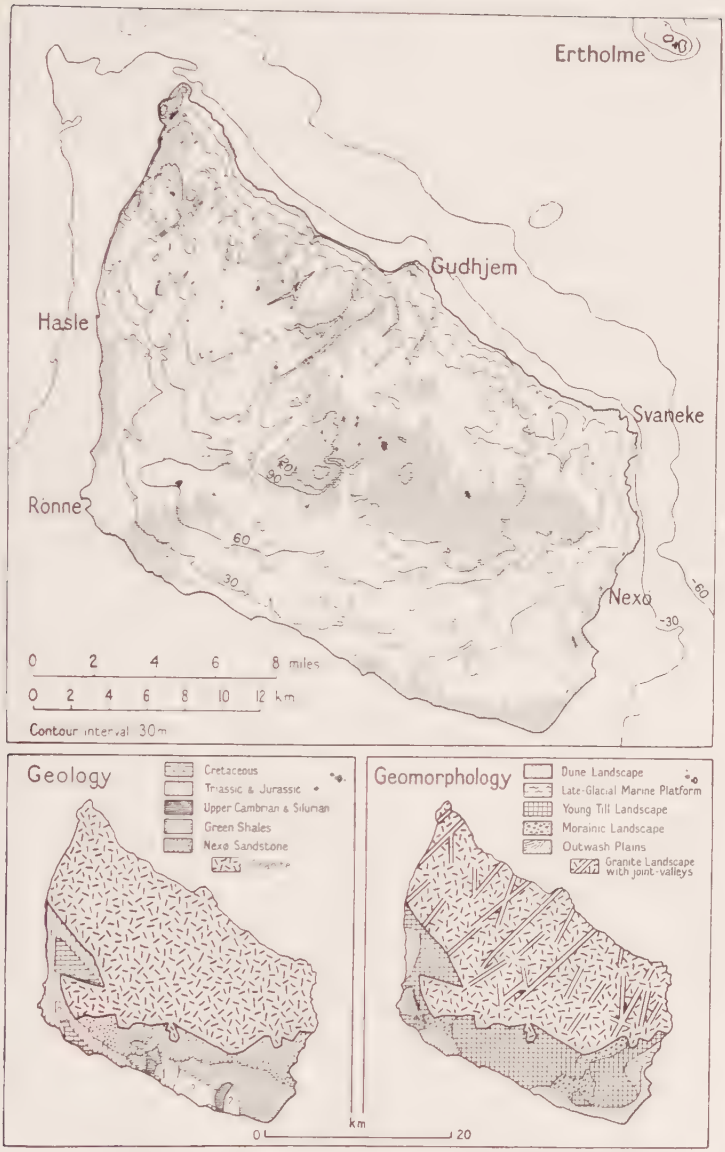


FIG. 76.—BORNHOLM.

The upper diagram shows relief with contours at 30 m. (98 ft.) interval. The stippled areas are the non-arable land *ca.* 1885 and this land is now mainly planted with trees. The lower diagrams show structural and geomorphological features which make Bornholm unique in the Danish landscape pattern.

Based on first edition of 1:20,000 and 1:100,000 maps of Bornholm and, by permission, on *Atlas over Danmark*, 1949. Submarine contours, in metres, added from Danish Chart No. 231 (1935).

which exploit the Baltic fisheries; the catching and curing of Bornholm herring is their mainstay. Rønne is conveniently situated to serve the granite and kaolin workings as well as the agricultural community. The population of Bornholm was 48,134 in 1960.

To the north-east is the small outlying group of Ertholme. This

*A.C.O.*1 [*August 1935*

FIG. 77.—BORNHOLM FARM.

This is a characteristic small farm in Bornholm with timber-frame walls and thatch roof. The potato crop is wilting on the dry sandy soil.

small group of islands has a peculiar administration, being under the Minister of Marine, and it ranks as a naval station although its modern strategic value is negligible.[1] One of the main problems of life on this igneous outcrop is water-supply and rainwater has to be collected in open tanks in which fish are kept to prevent mosquitoes from breeding.

[1] It was bombarded by the British fleet on 24th October, 1808.

CHAPTER 10

NORWAY

57° 58′ N.–71° 1′ N.
4° 30′ E.–31° 11′ E.

Norway has an area of 125,181 sq. miles (324,220 sq. km.) and an extension in latitude equal to that from London to Lisbon. The width is only 250 miles (400 km.) at the broadest part and in the north the width of the mainland is greatly reduced by penetrating fjords; from the head of Hellemofjord it is only 4 miles (6·5 km.) to the Swedish frontier. Its size and the attenuated shape lead to administrative difficulties and regional aloofness from the capital.

The land frontier is not a well-defined water parting, even where the watershed is followed, but rather a zone of sparse settlement. This land frontier is 1,584 miles (2,555 km.) long and of this 1,037 miles (1,673 km.) is with Sweden, 444 miles (716 km.) with Finland and 122 miles (196 km.) with Russia. The sea coast, ignoring the many islands and measuring straight across the mouths of the fjords, is over 2,000 miles (3,200 km.) in length. Jylland is only 70 miles (112 km.) distant across the Skagerrak and the dialect of the south coast of Norway has Danish elements which reveal a connection by sea independent of the former close proximity of the frontiers of Norway and Denmark near the mouth of the Göta, where before 1675 a tongue of Swedish territory only 9 miles (15 km.) wide separated Norway and Denmark. The zone which has most disputes over boundaries is that of Finnmark where for a long time Norwegian control was tenuous. Russians entered the Kola peninsula in the sixteenth century at a time when the Muscovy Company was sailing to the White Sea to trade with the Russians at the site which later was Archangel, and threatened by approaches from the east and west, the Norwegian Crown re-stated its claim to the area. From the late sixteenth century until 1612 Sweden also laid claim to Finnmark but abandoned it later, although no firm frontier was fixed with Sweden until 1751. One of the complicating factors in this northern territory was the presence of nomadic Lapps who could be taxed to provide revenue for a remote, and otherwise disinterested, Crown. Only in 1826 did joint control by Russia, Sweden (Finland) and Norway come to an end.

GEOLOGY AND RELIEF

Remnants of a peneplane developed in Pre-Cambrian times on the gneissic and schistose rocks of Archæan age in Fenno-scandia are found in southern Norway, where they form an extension of the Archæan mass of central and southern Sweden, but the geological continuity of this southern area is broken by the Oslo eruptives and by numerous enclaves of later rocks. The peneplane has been deeply incised by later erosion and it now appears fragmented, the largest remaining fragment being Hardangervidda plateau. During the Palæozoic period considerable deposits were laid down in a geosynclinal area. As a result of the Caledonian earth storm these sediments, along with igneous upwellings, were folded into a mountain system and highly metamorphosed by pressure from the west. The roots of this Caledonian mountain system remain as a zone of higher land, often with a marked step down to the older rocks—though the escarpment may mark the edge of the thrust zone and not of the geosyncline. Since the Devonian period, the land has remained above sea-level, except for minor marine transgressions, and if it had not been for uplift during the Alpine earth-storm the landscape, after long continued sub-aerial erosion, would have been that of a low shield.

During the Ice Age Norway experienced more than one major glaciation: the first covered the whole country while the last was possibly slightly more restricted with nunataks of higher ground rising above the ice surface. While this last glaciation was not so widespread it was responsible for the final features of an ice-moulded landscape which we see to-day, altered only slightly by erosion. All the features of glacial erosion of a highland are present but those of lowland deposition are restricted to small areas round Lista and Jæren, for the ice-sheet carried most of its burden beyond Norway. As the ice melted the land rose and exposed marine deposits; naturally there is a greater development of these on the gentler slopes of the Oslo region, where post-glacial uplift has been greatest, than on the steep flanks of the western seaboard which was less affected by this uplift. To-day there remain but a few small and scattered ice-caps.[1] The snowline in both northern and southern Norway is generally at about 6,500 ft. (2,000 m.) above sea-level although the height on any one slope varies with aspect and the amount of precipitation in the gathering grounds. Jostedalsbreen, between Nord and Sogn fjords is the largest ice-sheet in Europe, excluding Iceland, whilst that of Svartisen in the north descends closest to sea-level. About 1,200

[1] These ice areas may not be true relics of the Ice Age, but ice patches, which have formed again after the post-glacial warm period.

A.C.O.] [*September, 1953*

FIG. 78.—JÆREN.

Farming landscape in glacial deposit region of Jæren with more barren uplands rising beyond (see Fig. 99).

A.C.O.] [*July, 1932*

FIG. 79.—SVARTISEN GLACIER.

Svartisen glacier leads from an ice-field of 230 sq. miles. This lobe of ice, which is in retreat as can be seen from the lighter colour of the bottom of the mountain side to the left of the picture, is the only glacier on the continent of Europe which descends almost to sea-level.

sq. miles (3,000 sq. km.) of snow- and ice-fields occur in Norway but this area is rapidly diminishing.

The relief of Norway is characterised by certain physical forms and it is the interplay of these, and their varying development, which leads to regional differentiation. Along the whole coast, with limited exceptions, is developed a skjærgård, that is a belt of generally bare skerries, stripped of rotted rock by ice and marine erosion, which can vary in height from a few feet to over a thousand feet (300 m.). Along the coast are about 150,000 islands, practically all of which occur north of Stavanger. The spring-tidal range at Vega is about 10 ft. (3 m.), that is considerably greater than in southern Norway and this enlarged tidal range widens the zone of marine erosion, though the latter is actually of little significance anywhere in Norway. Many of the islands and the adjoining mainland are fringed by a low, flat foreland known as the strandflat. This is a rock terrace, often with a broad belt of low skerries, which lies in front of the high mountainous coast between Lindesnes and southern Finnmark; it is partly backed by an abrupt cliff-like scarp. It reaches its greatest width of 37 miles (68 km.) near Hitteren and Frøia. Although upstanding masses may occur in it the strandflat appears as a planed surface. There have been several theories to try to account for its characteristic features: Reusch explained it as a plane of marine abrasion in the pre-glacial period, Richter as a wave-cut platform of inter-glacial times, Hansen as an Ice Age phenomenon due to wave erosion and scour from drifting ice; Nansen thought it was produced by marine denundation helped by sub-aerial frost action, whilst Ahlmann leans towards sub-aerial erosion locally assisted by glacial erosion. At its inner edge the strandflat rises to 130 ft. (40 m.) and Nansen believed that three strandflat levels could be distinguished. These resulted from three inter-glacial periods, the general constancy of levels being due to variations of sea-level and not only to isostatic adjustments as the ice-sheets vanished. Where the strandflat is absent, as along the coast of Finnmark, this may be due to the inability of the schists to resist vigorous erosion in the most recent geological period. The significance of the features of this type of coast to Norwegians may be gathered from the wealth of names applied to off-shore features: *tare* (a skerry showing seaweed at low water), *bo* (a shoal near the surface of the water), *flese* (a flat skerry), *brake* (rock with heavy breakers), *flu* (skerry below water), *stabbe* (a high rock), *falle* (a shoal where breakers often seen) and *drage* (a long rock).

Cut into the mainland are the partly submerged glaciated valleys which have given their names—fjords—to this type of feature. The longitudinal profiles of these fjords fall gently towards their mouths,

reaching considerable depths in great fjords such as Hardanger and Sogn, but all are shallow at the threshold. In Finnmark the fjords become broader and shallower, having been eroded in schist by small glaciers. The fjords are being gradually filled by the deposition of deltaic material by the torrents entering them. Rising above are the plateaux which form the highland of southern Norway, culminating in the Jotunheim where a plateau surface of 5,000 ft. (1,525 m.) can be distinguished. Deeply incised as these plateaux are by pre-glacial, glacial, and post-glacial rivers which have carved them into separate units, called fjell, they share the common features of ice-rounded contours and sparse vegetation. Occasionally there rise above the warped surface of the plateaux nunataks of resistant gabbros and conglomerates, etched by corries (*botner*); the highest of these peaks is Galdhopiggen, 8,100 ft. (2,469 m.). The ice streams which deepened the pre-existing valleys ran from a parting east of the present watershed and as a consequence the highland is breached by through valleys. Lesjeskog lake lies in one such depression, and from it the Rauma flows west to Romsdal fjord and the Lågen east to join the Glomma. Of the coastal districts only Lista and Jæren have considerable lowland deposits of morainic material. Elsewhere there are only narrow fragments of marine terraces, left after uplift and subsequent denudation; but since these terraces provide flat land and material which weathers to better soils, the fragments are of unusual significance.

CLIMATE

Climatically Norway has marked characteristics due to three factors: it lies for over 13° of latitude across the belt of northern hemisphere temperate latitude cyclones, it is athwart the drift of warm water and air from the western Atlantic, and the relief is abrupt along the western seaboard but gentle to the east of the water-parting. In accordance with these factors the weather and the climate change rapidly in time and from locality to locality. Even in Bergensdal, open to maritime influences, there are very considerable local varieties of climate. The importance of cyclones in affecting weather was responsible for the fundamental research by Vilhelm Bjerknes of Bergen and his collaborators, which resulted in the modern interpretation of air-mass movements. Owing to the vast volume of the drift of warmth across the Atlantic, temperatures are above the mean for their latitude; indeed near the Lofotens there is the greatest known positive temperature anomaly in the world, about 45°F. (25°C.) for January. This gulf of warmth does not, however, penetrate with any strength into the Skagerrak and so maritime influence is not very

pronounced in south-eastern Norway, while the continental influences from the Baltic region can easily cross the gently rising ground of Sweden. Since the land rises steeply from the west coast, and since so many of the valleys are longitudinal the warming influences may not be able to penetrate far inland and locally conditions are similar to those which prevail along the mountainous seaboard of British Columbia, where the temperature decreases inland more rapidly that it does northwards. Besides barring maritime influences, the fjell, by their very height, reduce the temperature at the rate of 1·2°F. (0·7°C.) for every 300 ft. (92 m.) of ascent and this, with increased orographical precipitation, accounts for the lingering-on, or renewal, of permanent snowfields in Norway. With steepsided U-shaped valleys temperature inversions are common and the frost danger is so great on still nights in August that farmers in such "frost-pockets" as Skjåk are compelled to co-operate in producing smudge-fires. In upper Gudbrandsdal where strong winds can prevail alternating periods of freezing and thawing spoil the pastures by "ice-burn". This trouble is being controlled by snow-traps, consisting of parallel lines of wooden fences at right angles to the run of the strongest winds; the fences help to conserve a snow cover which protects the grass.

Precipitation varies considerably across Norway, the area of lowest fall covering the headwaters of Ottadalen and Gudbrandsdalen and extending east to Østerdalen, for these are in the rain-shadow of Jotunheimen and Jostedalsbreen. From the agricultural aspect interest centres on the rainfall in the growing months April to September although snow-melt water is available in May. The seasonal distribution in the drier areas is such that these have drought conditions in summer: for example in western Ottadalen there is only 2 in. (5 cm.) of rain from March to June and the light, sandy soils are deficient in moisture when it is most needed. While even these average figures show that this is an inadequate rainfall, there is a further drawback in that rainfall varies considerably from year to year and complete drought can prevail for over six weeks. Temperatures in these rain-shadow valleys tend to be high and the rate of evaporation is great, so that more water is required to satisfy crop needs. The farmers have been driven to practise irrigation and as early as the seventeenth century it was a fully developed art in Norway. According to tradition irrigation commenced in Ottadalen and spread from there and became applied to meadows as well as to cornfields. During this century the practice has become less common partly because grain could be imported cheaply and partly because it was found that deep ploughing and frequent harrowing would conserve soil moisture. As a result irrigation is now only

practised in those districts most requiring it, namely Lærdal and lower Årdal and, in the east, Vågå, Skjåk and Lom parishes. One of the problems is securing a perennial flow of water and the leats are up to 10 miles (16 km.) long; with the retreat of the glaciers, they have had to be lengthened. Most of the leats of this traditional method of irrigation were trenches cut in the soil but where there were rock outcrops, or where the soil was porous, it was necessary to provide timber or concreted runnels or piping.

The maritime influence is not entirely an asset for the western region because, although the length and the intensity of winter are reduced, the summer temperatures are lowered and the cloud cover so increased that the climate is not so favourable for agriculture as in the valleys of the south-east, with their more continental summers, even though the winters are more severe. The winters have little effect on settlement, for firing and building materials are in adequate supply and the cold, dry air of the east is less trying than the raw windiness of the west where the house-heating season is just as long. The wetter areas have the problem of drying hay, and wooden racks, or the more modern wire racks, are in common use.

The length of day varies tremendously: at the North Cape the sun is wholly above the horizon from 14th May until 30th July, while at Mandal the nights are light from the end of April until the middle of August; but the reverse side of the picture is seen in winter, and at Tromsø the sun does not appear from 26th November until 16th January. Even at Trondheim the sun rises in midwinter at 10 a.m. and sets at 2.30 p.m.

Climatically Norway falls into three regions: the south-east, the west and the north. The south-east, south of Dovrefjell and east of the mountains, is characterised, except in the coastal fringe, by warm summers and severe winters; the rainfall is under 48 in. (122 cm.) and much of this precipitation falls in July and August. West Norway has a smaller range of monthly temperature and maritime influence is also seen by the delaying of the minimum temperature until February. Rainfall is usually considerable, with the wettest period in the late autumn and in early winter. Norway north of the Dovre upland has a maritime climate on the coast but temperatures decrease with higher altitudes and latitudes and Finmark is the coldest, as well as the driest, part of Norway; rainfall also decreases rapidly inland and diminishes gradually north of Svolvær.

SOILS AND VEGETATION

Because of the heavy stripping of the weathered rock during the Ice Age the more useful soils of Norway are only found in limited

areas, as in the Trondheim and Oslo districts, in the Jæren and Lista lowlands and on the floors of valleys and on deltaic fans. As a result of post-glacial uplift marine clays in the Oslo region extend up to about 600 ft. (200 m.) above sea-level, but active erosion has left only discontinuous relics, and almost everywhere cultivable soil occurs in irregular patches separated by screes and bluffs of bare rock. Most of the soils lack lime and phosphorus and so are cold lands. Since the war there has been a great increase in the amount of artificial fertilisers used in Norway compared with the pre-war consumption because, in view of the need for improvement, there has been a heavy subsidy. Usually the soils with a clay content are more fertile but some of the clay loams need drainage as the climate is so moist. In the fjord districts the best soils occur where shales outcrop at cultivable heights; in the eastern valleys the best soils generally occur on the lower valley slopes where there is underlying morainic clay and where soil has accumulated by downwash from higher slopes. There is a clear correlation between the Cambro-Silurian lowlands and some of the more fertile areas.

The natural vegetation over much of the lower land of Norway is forest; the chief trees are Norway spruce (*Picea excelsa*) and Scots pine (*Pinus sylvestris*) which reach altitudes of about 3,300 ft. (1,000 m.) in eastern Norway, 1,640 ft. (500 m.) in Trøndelag and 1,000 ft. (300 m.) in sheltered districts of Finnmark. The pine predominates on dry ground and extends somewhat higher up the slopes than the spruce. In the lowest land of the south soils are deeper and there is more shelter; here are found oak, ash, lime, elm, maple and the lowland birch (*Betula verrucosa*). Under more severe conditions there is always a sprinkling of birch (*B. odorata*) among the conifers. In the area immediately east of the mountains, the upper limit of tree-growth becomes lower: the reduction of height is estimated at 26 ft. for every mile (5 m. for every kilometre) going eastwards in Møre "fylke". For some 600 ft. (200 m.) above the conifer-clad lands runs a zone of birch and above the tree-line is a zone of alpine and arctic vegetation, locally dominated by reindeer moss (*Cladonia rangiferina*), which passes into barren stony wastes in the highest land where soils form slowly. This vertical zonation of plants is often interrupted locally; for example, peat bogs develop on flat, ill-drained land at most altitudes, being, however, most frequent in the wet west. In southern Norway the west coastlands are barren, except in sheltered patches, but at the head of the fjord valleys the flora may be rich and luxuriant although some areas such as the head of Sognefjord are very dry. Farther north the West European species disappear near the coast and the vegetation is poor in variety, but cloudberries (*molter*) occur profusely in the bogs and the fruit is

shipped southwards. Of the trees forming the forests the pine entered Norway first, but it is now being ousted by the spruce which is pressing north and west from the southern sector of the frontier with Sweden.[1] North of the Arctic circle spruce is only found in quantity in Dunderlandsdalen. In the southern part of Norway beech and oak entered from Sweden as the conditions became milder after the last glaciation. In historical times pine forest has disappeared near Roros; this loss was partly due to the consumption of wood as charcoal in the copper smelters, but the change was not exclusively due to this.

POPULATION

After the last retreat of the ice sheet man penetrated to the west coast where he was attracted by the opportunities of hunting and fishing. The Neolithic people, having introduced agriculture, continued to inhabit Scandinavia after the Bronze Age had commenced in the more favoured south; it is probable that the Bronze Age culture was active in south Norway from *c.* 1500 to 600 B.C. In the seventh century B.C. an Early Iron Age culture flooded in from continental Europe and it was people with this culture, termed "Nordic", who first colonised most of northern Norway. To-day the modified Nordic people form the principal component of the population of the country. They are tall and long-headed with a fair colouring.

In the opening-up of the forest lands east of the Glomma, a Finno-Ugrian element entering *via* Sweden from about 1600 onwards was added to the population, but the numbers were never great and they have become absorbed. During the eighteenth and nineteenth centuries there was a further considerable immigration of Finns but this time into the two northern provinces; these people are known as *Kvæns* and they have intermarried freely with both the Lapps and Norwegians.

Only in the south of Norway, therefore, is there a marked admixture of darker, shorter people, apart from the Lapps. The Lapps of Norway, who number under 9,000, entered the country possibly in the ninth century A.D. from Siberia *via* Finland. They are not of true Asiatic mongoloid type but are short the men average 5 ft. (152 cm.) in height—with broad heads and a tendency to dark colouring. Their language is allied to that of the Finns. There is no foundation for the belief that the Lapps were the first to colonise

[1] The nineteenth-century technique of cutting, which left a canopy of tall trees, encouraged the spruce to spread at the expense of pine because it is more tolerant of shade.

Norway and it is certain that they came in as nomads, with an "arctic stone-age" culture, later than the main component of the present Norwegian population. Their numbers have varied in the north as shown below:—

1567	. . .	4,000	
1724	. . .	7,000	
1845	. . .	12,000	
1891	. . .	20,000	
1930	. . .	19,000	
1950	. . .	8,800	(decline due to changed definition by language instead of descent)

While their numbers have probably been maintained in recent times, the Lapps and Finns have been swamped by the vast increase in the numbers of Norwegians in the provinces of Finnmark, Troms and Nordland, but efforts are now being made to preserve the Lapp culture. Many of the nomadic Lapps have abandoned their traditional following of the reindeer and settled in one home.

Ripley describes two main racial types in the Norwegian people—one brachycephalic and the other dolichocephalic: the former, of Alpine affinities, is darker haired and shorter than the other or Teutonic type. Ripley considers the short-headed type came from the south by way of Denmark and settled on the coast but were unable to spread inland because of the Teutonic immigrants from Sweden who occupied the interior. There are many intermediate types and near the Swedish border at Trysil, in Hedmark, and in Solør a somewhat Mongolian featured type appears (possibly Finn or Lapp). The southernmost area of Lapp reindeer breeders is at Trysiland-Dalarne in Sweden, but these people should be distinguished from the Finnish settlers in Värmland-Solør.

The population of Norway is about three and a half million, less than half that of Greater London, and the average density is the lowest in Europe except for that of Iceland. As in the other Scandinavian countries the numbers of the people have fluctuated. During the mediæval period one-third of the population died in one year as a result of the ravages of the "black death", and much land became waste and remained deserted until five generations had passed.

Out of the present population over one-half are concentrated in the towns but many of these urban units are small and have a strong linkage with rural life. Most of the towns are found along the coast and only in the Oslo region is there much divorce from a seaboard location. Land shortage has long been felt, particularly in the west, and a law was passed as early as 1634 to prevent sub-division below the minimum for the support of a family. With intense population

[1] About seven-eighths of the Norwegian Lapps are in Finnmark and about two-thirds of the remainder are in the Troms region.

pressure on the agricultural land, the density within the farmed areas is high, for example over 425 persons per sq. mile of farmland (165 per sq. km.) in Valdres and in North Gudbrandsdal. Any surplus has been lost by migration to the developing industrial and timber centres, particularly Oslo, or by emigration; by the end of the last century one-seventh of all Norwegian born persons were living in North America. Between 1836 and 1915 no less than three quarters of a million persons left Norway. For a period emigration threatened some rural areas with depopulation, but since it has been restricted, pressure on the land is again becoming a problem, particularly in the west where, despite the unfavourable conditions for agriculture, much of the land emptied by emigration has again been occupied. There is now an eastward drift from the fjord regions. To-day about the same number of people is engaged in agriculture and forestry as in 1801, but the proportion has declined from about four in five of the population in 1801 to one in five in 1950; in this same period those engaged in industry have increased from 50,000 to over one million.

LAND USE

The following table shows, on a percentage basis, the use of the land in Norway:

Land use in Norway

1898	*Land use*	1939
0·1	Urban	0·1
0·7	Arable	2·7
1·2	Cultivated meadows	3·7
1·0	Natural „	
21·1	Forests	25·2
7·6	Pastures	
3·7	Bogs	3·7
59·2	Waste mountains	59·2
3·8	Lakes	3·8
1·6	Snow and ice	1·6

(Based on 1898: *Norway*, 1900
1939: Statistisk Årbok for Norge
65–67 Årgang, Oslo, 1948.
Table 63 *et seq.*)

With steep slopes, sparse and poor soils, a moist climate and over half the area at least 2,000 ft. (600 m.) above sea-level, agriculture is handicapped and few other countries have such a limited proportion of farmland. Farming is restricted to the lower slopes of the valley

sides and to the few lowlands, including the bottoms of valleys where they are not flooded. In the Oslo region the farms, each consisting of a cluster of buildings very different from the Danish court system, are strung along the valleys near the lower edge of the forest. In the western valleys the farms are in the middle of the improved land as the ground is precipitous elsewhere and vulnerable to landslides and avalanches and to river floods. This location of the farm buildings does reduce haulage of the crops and of dung. The steep land in some districts can be ploughed only with horses and the use of tractors is limited. On account of this handicap to mechanisation, horse-breeding is still encouraged by the State, for the Norwegian breeds are invaluable to the farmers.

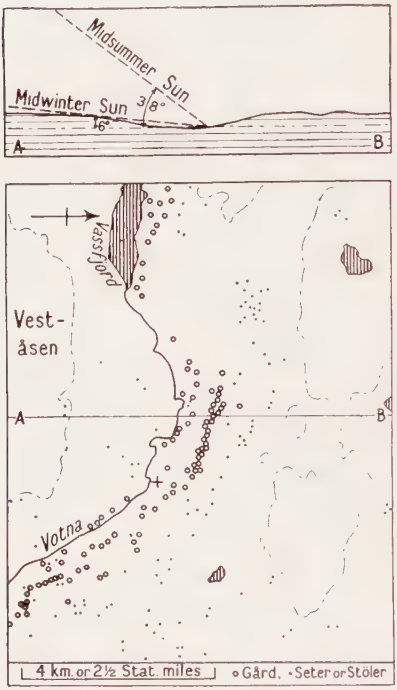


FIG. 80.—ASPECT CONTROL IN HEMSEDAL.

The section A–B has the same vertical and horizontal scales and the approximate angle of incidence of the noon sun at midwinter and midsummer is shown. The contour of 1,000 m. (3,300 ft.) is shown by a light pecked line. The co-ordinates for the top left-hand corner of the map are 11° 03′ E. of Greenwich and 60° 40′ N. T. Sund and A. Somme in *Norway in Maps*, Bergen, 1947 have shown the significance of aspect in such valleys of Norway.

Based, for settlements and contour, on Hemsedal, 1:100,000 map (revised 1937).

While the best soils are in the east, the density of rural settlement is less than it is in the more congested west. Until the creation of modern transport nodes rural Norway was a land of isolated, self-contained farm units sited on the patches of soil, producing their own food and clothing, and not a land of villages. Feudalism never became established in Norway and there was always a predominance of peasant-proprietor groups, except in Finnmark where the land-owner is the State. Legislation has long preserved the right of the eldest son or heir to recover land sold to strangers. Once there was common ownership of land but because of the difficulties which strip cultivation imposed on improved agricultural techniques common ownership

has tended to be restricted to pastures and grazing land. Strip cultivation with village settlement was, however, common in western Norway before legislation of 1857 led to redistribution.

Traditionally there was a multitude of separate farm buildings, one for each demand for shelter, but during the last hundred years the number has been reduced by concentrating on a few large units. Building styles have been affected by local conditions. Where houses are set against cliffs the roofs continue the line of slope in order to facilitate the passage of avalanches. In the forested districts tree-trunks were freely used for building construction, but in the north and west of Norway the more economical plank is used. Even in

A.C.O.] [*September, 1953*

FIG. 81.—TRADITIONAL FARM BUILDING AT VOSS.

the east the need to conserve timber, and the demand for firewood have led to the abandonment of rough pole-fences and their replacement by wire; in the west, stone walls have been substituted. All modern houses have stone foundations; since these have to be deeper than the zone of frost-heave, they provide frost-free cellarage, space. Roofing is also affected by local conditions; tiles at one time tended to replace the traditional turf, birch bark or shingle roofs but they were found unsatisfactory because they were destroyed by frost and so have been replaced by the more expensive slates or the inexpensive corrugated sheeting. Traditional house styles fell into three types; eastern, western and northern. In the eastern area, where firewood was easy to obtain, open fires, which gave light to the room, were usual; in the western and northern areas, where

Photograph by courtesy of S. H. Beaver] [*August, 1951*

FIG. 82.—SEMI-TRADITIONAL BUILDING AT DALE-I-SUNNFJORD.

timber was scarcer, more economical fireplaces were used and light was provided by fish-oil lamps. In the northern houses rooms occupied the whole width of the building so as to get as much natural lighting as possible during the short winter days. These traditional styles still linger on, particularly on the poorer lands; the richer

Photograph by courtesy of S. H. Beaver] [*August, 1933*

FIG. 83.—MODERN BUILDING AT FLÅM.

properties, such as those where capital was gained from the timber trade booms of the 1870s, often have non-indigenous styles of architecture.

Although one-quarter of the population is engaged in agriculture, the country is so handicapped by the natural conditions that only about one-fortieth of the surface is cultivated and the economy is controlled by the livestock industries. The main centres of arable farming are in the south-eastern region, the Jæren district and around Trondheimfjord. With a short growing season and a heavy precipitation grain cultivation, except in the south-east, is limited to quick-maturing varieties of the hardier cereals—oats and barley. Barley ripens in about eight weeks at 70° N. but takes nearly twice as long in the south of Norway. Mangcorn, a mixture of oats and barley, gives a greater yield than either grown separately but its use has now been largely abandoned. Rye cultivation is limited by the length of growing period available but nevertheless it was for long the chief bread grain, though to-day only some 2,500 acres (1,000 ha.) are under rye. As a result of the use of fertilisers crop yields are surprisingly large and have been increased greatly during the present century.

Yields in 1960

	Cwt per acre	*100 kgs per ha.*
Wheat	20·3	25·0
Rye	20·8	25·6
Barley	21·8	27·6
Oats	21·6	26·6
Mangcorn	22·7	28·0
Potatoes	178·7	220·0

(Based on *F.A.O. Production Year Book*, 1961, Tables 11–15 and 23)

In the sheltered valleys in the lee of the plateaux rainfall is low and it is necessary to irrigate the crops; but irrigation is difficult on account of the incision of the rivers. Potatoes, easily grown and maturing in sixteen weeks, form a staple element of the diet. Although the acreage under crops has increased only slightly since 1900 the yield is now almost half as great again owing to improved varieties and technique. The agriculture turned more to arable farming during the First World War but largely reverted to traditional pastoralism after it. Various rotations are practised but a

common one is the six-year shift—cereal, roots, cereal and three years in grass—which is the same as that commonly used in north-east Scotland. The farming season lasts only from April to the end of October so the demands on labour are then intense, while in the long winters the cattle must be stall-fed.

With such a strong maritime influence in the climatic conditions pastoral farming is dominant, although the severity of the winters usually entails sheltering the beasts over winter and this places a limit on their numbers. Sheep numbers are surprisingly low, probably because in most parts of the country even they have to be housed in winter. Dairy farming is the principal interest. The milch cows are small and hardy and although attempts have been made to cross Norwegian cattle with Ayrshires and Friesians, the native breeds are important to the farmers for they are able to live in mountainous country by roaming widely. Red-Polls are found in the south-east, the Red Trondheim (a cross with Ayrshires) round Trondheim fjord and in the south-east, Døle cattle in the eastern valleys, Vestland in the west and Røros cattle in the northern districts. All are now primarily bred for milk production and there has been a considerable increase in milk yield per cow since records were first kept in 1865 but the yield is still only about 400 gall. (1,820 litres) a year. Goats supplement the supplies of milk from milch cows. The increased production of milk between 1875 and 1930 went to cheese manufacture. As in Britain there is a Milk Marketing Scheme to stabilise prices, but in Norway participation is voluntary.

Through improved crop rotations, after the introduction of turnips, and by the use of hay, the animals can now survive the rigorous winters. The sending of the animals to the sæters in the summer permits hay to be taken off most of the home meadows. The farmers of the eastern area used to supplement the limited hay supplies by collecting and storing leaves and *Cladonia* lichen ("reindeer moss") and this provided a valuable reserve for winter fodder. The Norwegians are an intensely individualistic people but large-scale co-operation was forced on them about 1870 when they wished to sell butter in distant towns and in Britain, both of which demanded standardisation of products. The first co-operative dairy in Norway was established in 1855 which compares with 1815 in Switzerland, 1851 in the United States, 1882 in Denmark and 1889 in England. The dairy industry rapidly developed in Østland in the 1860s, in Trondelag in the '70s, in Vestland in the '80s and finally in the north in the '90s. Much of the milk is now sent to co-operative dairies where it is used for butter, cheese, casein and condensed milk production but expenses are high, because difficulties of transport limit the areas on which the dairies can draw and the quantities handled

at most of the creameries are small compared with those of Denmark and Sweden. Many districts have established co-operative flour-mills, in place of the old drying and grinding of corn on the farm, while the parishes around Hamar, which have surplus potatoes, have co-operative distilleries. When railways shortened journey times farmers, instead of selling their surplus beasts at the yearly markets or to itinerant dealers, preferred to send them to co-operative stock markets and slaughterhouses in the chief cities. The rise of co-operation has made the villages transmitting stations between the countryside and the city rather than centres of local exchange.

Goats, although numerous, have been declining in numbers as in Switzerland, because of the damage which the animals cause to the forest lands. While sheep occur in many parts of Norway the most important districts for them are Jæren and the Bergen strandflat where the mild winters allow them to remain without cover. A speciality in the agriculture has been the breeding of silver fox and other fur animals and between 1925 and 1940 Norway became one of the leading suppliers of silver fox furs. Since the war silver-fox has not been very profitable and to some extent mink has taken its place.

Over nine-tenths of the farms are worked by owner-occupiers, for the peasants have had since 1650 the opportunity of buying from the Crown or nobleman-proprietors the land they farm. The size of the cultivable holding is so small in many districts—averaging only about 4½ acres (1·8 ha.) of arable land—that the farmers have required rights in the forest and in the out-lying pastures in order to eke out a living. One unfortunate result of the legal system which, in effect, entailed the land, that is, bestowed it as an unalienable possession, was to reduce the incentive to colonise fresh areas, so that some districts became overpopulated while others needed workers. Between the two world wars the Government endeavoured, rather unsuccessfully, to increase the productive use of the land by an Expropriation Law (1928) which permitted the taking over of land not in full use, by making available loans and subsidies and by land improvement works such as drainage. The sæter system, a kind of transhumance older than written records, was evolved in southern Norway but is now losing much of its significance, and the higher and more remote sæters are being abandoned: in 1800 there were 60,000 sæters in use, in 1907 44,000 and by 1939 only 30,000. During the Second World War when imported feeding-stuffs were unobtainable there was a revival of interest in the sæter pastures. Modern tendencies are to co-operate in the running of the sæters which serve a central dairy, and in the transport of the liquid milk. By the sæter system it was possible to take advantage of summer pastures, remote from the farms and above the limit of permanent settlement.

Typically sæters are found between 2,000 and 3,000 ft. (600 and 900 m.) but occur at all heights from 150 ft. (45 m.) to 4,000 ft. (1,200 m.) above sea-level. About half of the area of Norway, excluding the three northern "fylker", lies above 2,500 ft. (750 m.), that is above the limit of good forest. Much of the area lies so high as to have only bare rock or snow cover but it is fringed by a belt of hill-pastures of natural grassland. In the lower lands are "forest-pastures", ling-covered lowland pastures (particularly developed in Jæren) and the valley-pastures in the narrow mountain valleys of the west. The hill and valley pastures provide better grazing than the forest and moorland pastures. The hill-pastures have fine grasses of high nutritive value but of semi-bunch growth, which cannot carry a great head of stock but the extensive grazing system can take advantage of the progressive fresh exposures as the winter snow melts. Many of the sæters are situated on the high flanks of the valleys, and not on the tops of the plateaux, and thereby can take advantage of the zonation of vegetation and of the different growing periods. The valley pastures, unfortunately of limited area, can carry a heavier stock, and indeed it is often the liability to avalanches rather than soil-poverty that prevents arable farming. The poorer forest pastures occur in the drier east with masses of heather and berry plants as an undergrowth, whereas the moorland pastures are found in the west on light or peaty soils. The forest pastures are not likely to be improved as grazing is incompatible with good forestry. The use of the sæter pastures is more a matter of the location of the home farms than of the quality of the out-grazing, and remote pastures on the plateau tops are not utilised whereas in the east poor quality forest-grazings are exploited. It is in the districts where the sæter grazing is poorest that the system is most quickly passing into desuetude. The introduction of grass into a rotation, a significant change in farm economy, has increased the carrying capacity of the home pastures and it is believed that the sæter system will die out except in the plateaux and western valleys, where pasture and property conditions are most favourable to it, even though it is easier to construct roads to serve the sæters in the east. One of the problems is a supply of firewood, but this has been eased by the provision of better roads.

Normally the sæter pastures, which are specifically attached to an individual farm, are relatively close to the holding but they may occasionally be up to 70 miles (112 km.) away. The cattle, sheep and other livestock are moved in the early summer and brought back in September; the actual dates may vary according to the winter fodder available. Also more than one sæter-hut may be used in the course of a season so as to obtain the maximum utilisation of a group of

pastures. Once at the sæter the cows are milked close to the hut, which may vary from a mere shelter to a substantial structure, but the other beasts are taken to the more remote pastures. The sæter huts tend to be placed near the tree limits, where some fuel will be available, as well as near a water supply. Because of the difficulties of transporting fresh milk most is used for the manufacture of butter but one modern development is the transport of the churns down a wire-hawser stretched down the sides of the steep-sided valleys of the west. In the more open valleys of the east lorries carry the milk daily to the creameries. The manufacture of butter is most common in southern Norway west of the Oslo region.

A.C.O.] *[August, 1955*

FIG. 84.—REINDEER AT HONNINGSVÅG.
The group in the foreground consists of a stag, hind and calf.

The sæter system brings isolated workers closer together, an hour's walk away as contrasted with say, a day's journey between farms and this has been taken advantage of for schooling in districts with a remote scattered population, where classes could only assemble during the ten weeks of the sæter season. This transhumance also played a considerable part in the social life and encouraged marriages between young people from isolated valleys where otherwise intermarrying would have been the only choice.

In the north, where reindeer are the mainstay of the rural economy, beasts of prey, such as the glutton and the wolf, are a problem. Wolves were once very numerous but, owing to disease, they disappeared from northern Norway about a century ago; the only

southern centre still with wolves was Røros and from this breeding nucleus there have been sporadic eruptions. Reindeer herds were originally confined to the north but they are now being kept in the south, in some places by Norwegians, to utilise the mountain grazings. A reindeer has a live weight of about 260 lb. (117 kilo.) and it provides subsistence for the nomadic Lapps who need at least 200 head to sustain a family. In 1898 the number of reindeer was 170,000, but by 1958 it had decreased to 103,500 (pre-calving figure).

INDUSTRIES

The industrial aspects of Norwegian economy, based on fisheries, minerals, timber and hydro-electric power, are more considerable than is usually realised and have been important since factory industry developed in the 1860s. The greatest zone of activity lies around the towns of the south-east, and around Stavanger and Bergen although water-power has attracted large-scale consumers of electricity to lonely valleys such as Rjukan. Norway has become a manufacturer of aluminium, using imported ores and aluminium oxide, because of the abundance of the developed water-power; the largest of the producing units is at Årdal, Glom fjord. Other activities due to water-power are zinc and nickel refining, the manufacture of steel alloys and chemical production. The electrochemical industry is based on the fixation of atmospheric nitrogen and a great range of chemicals is produced, including explosives. The major centre of this activity is in the Skien valley. The electrochemical and electro-metallurgical industries use about two-fifths of the power produced. Associated with the development of hydroelectric power is the engineering industry, which specialises in turbines and other power plant.

Norway developed $6\frac{1}{4}$ million kw. ($31\frac{1}{3}$ million kWh. in 1960), and this represents about a quarter of the potential. The terrain is well suited for this development; the many hanging valleys, and valleys with breaks of slope due to uplift provide the falls, whilst the many deep lakes help to even the flow and remove sediment. Although the precipitation is relatively even it is unfortunate that so much of the winter fall is locked up as snow and the rivers have a peak flow in summer when many of the power demands are at a minimum. The lakes may freeze but there is always a flow of water at the various falls. Central and northern Norway are less well endowed for power development than the south; the rivers are either better graded or the catchment area is small. The southern part of the country is the most suitable and here many of the installations are near the navigable fjords: for example at the town of Odda on

Hardangerfjord imported zinc and aluminium ores are smelted, while at Årdal, near the head of Sognefjord, the Germans commenced the construction of a power station below ground, to avoid damage from bombing and from avalanches, and here aluminium is now produced exploiting the net fall of 3,202 ft. (976 m.).

The impact of this industrialisation on a fjord has been well described.[1] "The Höyanger fjord is only an arm of the Sognefjord on its northern shore, and Höyanger was previous to 1916 inhabited by a small number of farmers living peacefully on their small farms, where Dalelven joins the fjord. In the spring of 1916 the quiet of this idyllic community was rudely disturbed by a small fleet of transport ships, which arrived with machinery, material, workers and equipment. A quay was constructed, barracks and houses were erected, and soon the song of dynamite explosions and engine noises sounded harshly in the mountain quiet. The modern industrial age had reached the farmland. In the course of eighteen months the power plant, the smelter, the remelting factory and the electrode works were all completed. Höyanger grew into an industrial town and soon the barracks and other signs of the pioneer days were replaced by pleasant houses, gardens, roads and all the community centres so essential to the welfare of the workers and employees of the company. The industry thus created provided work for more people than those living there, and from all over Norway people went to live in Höyanger. The local dialect has been greatly influenced by the influx of people from other parts of the country. Soil was brought by boat to Höyanger to create the gardens, of which the town of Höyanger is justly proud. In a single year freight charges paid out for soil transport were more than kr. 50,000 [approximately £2,500]. To-day Höyanger is a lovely little town, surrounded by towering mountains. The population is 3,500 and all live by and for the company."

The works use bauxite from Provence and cryolite from Greenland in the production of aluminium which is then sent to a rolling mill at Holmestrand. Pig-iron is produced as a by-product in the preparation of the alumina, by fusing the bauxite with coke and limestone (the Pedersen process).

FORESTRY

The forest area of Norway is only inferior, per head of the population, to that of Finland, Sweden and Canada. From the fourteenth to the seventeenth centuries there was much deforestation in western

[1] From an account published by the Norsk Aluminium Company quoted in *Industries of Norway*, p. 54.

Norway owing to the ease of coastal shipment, fire loss, fuel supply demands (particularly for ore-smelting) and the need to extend the summer pastures, but there is now an attempt to increase the forested area by planting of spruce and to resolve the conflict between this and the agricultural use of the land. Since 1550 there have been numerous legal enactments to prevent overcutting but only in the northern forests, always State-owned, has there been effective control for long. Two-thirds of the forested tract is owned by the peasant-farmers, who are primarily farmers and not foresters. A Forestry Society was formed in 1898 to promote improved forestry practice.

The height of the tree-line varies considerably: in the Trondheim area it is about 2,300 ft. (700 m.) and in Østland 3,300 ft. (1,000 m.). In northern Norway aspect has a tremendous influence; for example, in protected Saltdal the tree-line is 330 ft. (100 m.) higher than in Stjørdal, near Trondheim, 250 miles (400 km.) farther south. At Polmak in Finmark the most northerly extension of the forests has an upper limit of 825 ft. (250 m.). Some of this increase in elevation of the tree-limit results from the longer days of the growing season.

There is a considerable timber industry, but it fails as a whole to absorb the annual growth increment. However, the annual rate of growth falls northwards from 22·8 cu. ft. per acre (1·57 cu. m. per ha.) in the south to 11·4 cu. ft. per acre (0·78 cu. m. per ha.) north of Trondheim, and it is in the north that cutting in excess of growth has been most serious in this century. Pine matures in a century in southern Norway and spruce in three quarters of a century whereas in the north the pine takes two centuries. The logs from the trees cut in the autumn and winter are moved over the frozen ground to the waterside and then floated on the summer floods down to the mills.[1] The rivers have been improved by timber-floating associations for floating loose logs, and flumes have been constructed past rapids. The bark must be stripped from the logs for the timber has to be floated quickly, as otherwise it either cracks or becomes waterlogged. The timber working industry is centred on the towns of Sarpsborg and Fredrikstad; wall-board at Gjovik, Drammen, Brumunddal, Larvik and Vennesla; paper and pulp at Drammen, Skien and Hønefoss; that is in the quarter of the country which has the greatest surplus of timber above its local requirements. Norwegian spruce, with its limited resin content, has been valuable as a source of pulp since the first pulp-mill was established in 1863, but

[1] Felling used to be carried out entirely in the autumn and winter but now it is maintained throughout the year for it is in summer that remote timber can be felled most conveniently. Timber felled in sap floats and dries well. If, however, timber is hauled out by motors then winter is a better season as there is no need to construct expensive roads.

now the paper and pulp industry cannot get sufficient timber for its requirements. The export value of the products of the forest now exceeds that of the fisheries.

MINERALS

Mineral deposits are numerous in the highly metamorphosed rocks of Norway but unfortunately the deposits are usually neither extensive nor conveniently situated for exploitation. The minerals which have been most worked are iron and copper ores and to-day they still remain the most important resources. The mining of low-grade copper ore at Røros during more than three centuries, and copper smelting at Tolga, lower down the valley where better supplies of charcoal could be obtained, led to the development of small villages. The copper-mine of Sulitjelma was opened late in the nineteenth century to work lenticular masses of ore set in schists. There have been many workings for pyrites. Iron ores are to be found in many places and were worked when charcoal was available and before smelting elsewhere by coke lowered the price of the pig-iron. Modern winning and treatment have been aided by the hydro-electric power but at Kirkenes the concentration plant is exceptionally powered by coal. A great range of other minerals has been worked, including nickel, cobalt, zinc, molybdenum and thorium, but they are all of minor importance in world economy. One of the celebrated mining districts of the seventeenth century was Kongsberg on the western border of Østland where silver occurs in association with iron pyrites and has been worked since 1624. A few seams of Jurassic coal occur on Andøya (see p. 469). An associated activity is quarrying and the principal production is that of building stone, namely granite, mainly from Østfold, laurvikite for ornamental purposes, limestone for cement

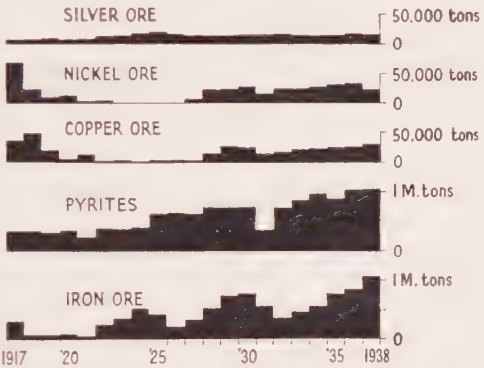


FIG. 85.—ORE PRODUCTION IN NORWAY, 1917–38.

The cyclical nature of the production of iron ore and pyrites is clearly brought out as also the relatively small quantities of the ores of other metals. Note vertical scales vary.

Based on Jubilee Volume of the *Norsk. Geog. Tidsk.*, 1939, p. 182 and *Industries of Norway*, 1952, p. 182.

production, marble, soapstone and slate. Other rocks extracted include felspar for making china, glass, sheet-iron enamel and a wide range of products, talc for refractory linings and graphite.

FISHERIES

Norway has a long coastline and waters varied in character, so the sea-fish fauna is varied. This wealth of the sea has long been exploited; a saga records that "splendid painted ships, with sails of several colours" sailed with fish from Norway to England. The fisheries are still valuable and to protect them the Norwegians have established since the war their claim to recognition of an extension of of the fishery limit in adjacent waters. To the coast of Finmark and the Lofoten Islands come shoals of Arctic-water fish such as cod, saithe, haddock and ling as well as the Greenland shark which is caught for the sake of its liver-oil. Farther south occur North European fish—cod, haddock, tusk, herring, mackerel and flat fish—the in-shore shoal movements of which are concentrated in the channels between the islands. The nature of the bottom affects the development of the fisheries, for the flat fish are obtained where there is a smooth, sandy floor and the cod by line-fishing where there is a rocky bottom. In the fjords, fishing is by seine-nets.

An important fishery is that for cod which migrate in from deep water at regular seasons which have not varied in time for centuries: the spawning migration of the mature (*skrei*) commences off Finmark in November and moves to the Lofoten Islands from February to April; the food migration off the Finmark coast, when the immature cod chase the capelin (*Mallotus villosus*) is from April to June. This latter period is not so valuable as the former for the fish are smaller and the Finmark fishery is, as yet, much less valuable than that of the Lofoten Islands (see p. 250), although it may develop as equipped shore bases are provided to handle the catch. There is a periodicity in the cod fisheries while the herring catch is also very variable in respect of both the western "spring-herring fishery" and the "winter large-herring fishery" of the Møre area. Since 1946 the Norwegians have trawled for herring in the North Sea from July to October. In good years the herring are caught in incredible quantities—for example, in February and March, 1951, four-fifths of a million metric tons were landed in Norway—and these glut catches, because of the difficulties of preserving, have to be used for fish-meal, fish-manure and fish-oil manufacture. In the deeper parts of some fjords live crustaceans, such as prawns: the Svelvik prawn was named from the town on the shores of Drammen fjord from which it was long caught in the winter months. While the rivers are limited in species of fish

they are rich in numbers of salmon. The enormous scale of the catches of all fish is revealed in the Table below.

Whaling was practised along the coast for ten centuries. Formerly the right-whale was hunted off Finnmark and then, in the last years of the last century, rorquals were taken. With the virtual extinction of these species in local waters, after the invention of the explosive harpoon by Svend Foyn in 1868, whaling activity spread further afield and the Norwegians are now the principal whaling nation in the world. The fishermen thought that the northern whaling was damaging the cod and herring fisheries and so whaling was forbidden from Norwegian shores in 1904 and base stations were established from Scotland to Iceland, but decreasing catches drove the whalers to more distant waters and now, in the Antarctic, the last of the whaling grounds, some 7,500 men participate in the Norwegian whaling voyages which last from September to May. The first floating factory was used in Antarctic waters in 1905.

Important fish treatment industries have grown up at the larger fishing ports—fish drying and canning (especially of brisling at

Fishery Catch and Processing of Norway, 1946–61 (Thousand tons)

	1946	*1947*	*1948*	*1949*	*1950*	*1961*
Winter herring	358	494	820	568	771	69
Fat herring and small herring	96	70	108	125	104	352
North Sea herring	1	4	6	3	4	14
Iceland herring	12	22	24	26	11	105
Brisling	11	8	7	10	6	9
Skrei cod	172	206	111	91	109	77
Spring cod, Finnmark	13	23	25	22	23	59
Bank cod	12	21	23	35	44	} 97
Fjord cod	17	20	20	28	20	
Cod by-products	30	33	20	21	26	?
Saithe	30	42	59	61	68	61
Haddock	9	15	25	21	18	46
Mackerel	7	15	13	14	10	15
Halibut	4	5	5	6	6	11
Flounders	1	2	2	2	2	—
Klipfish	30	51	33	32	42	34
Stockfish	14	16	10	9	20	35
Fish meal	9	16	13	13	16	13
Herring meal	50	55	111	72	129	131
Herring oil	15	22	42	27	53	59
Canned herring	25	35	39	37	32	27
Other canned fish products	8	13	19	18	12	12
Salted herring	71	95	110	115	59	17
Medicinal liver oil	10	12	7	8	9	15
Roe	9	5	3	4	5	?

(*Industries of Norway*, pp. 176, 179, 181 and 193, *Norges Fiskerier*, 1951, and *F.A.O. Yearbook of Fishery Statistics, 1961*)

Stavanger), the extraction of herring oil, the preparation of fish meal and the preparation of edible fats from herring and whale oil. The Norwegians are now producing from fresh herring a refined and

Marine Products Exported in 1881

	Tons
Salmon, fresh and iced	379
Mackerel, fresh and iced	1,829
Other kinds of fish, fresh and iced	146
Stockfish—	
Dried and split fish	1,770
Coalfish	3,377
Dried and round fish	13,597
Other kinds of stockfish	129
Dry salted codfish, etc. (klipfish)	41,918
Salted herrings—	
Spring or winter herring	4,956
"Large" herring	360
New or mixed herring	139
Fat or summer herring	71,591
Sprat	6,728
Iceland herring	9,740
Other kinds of herring	276
Salted fish, not referred to above—	
In barrels and kegs	1,410
In vessels	14,032
Anchovies	1,308
Smoked salmon	2
Smoked herring	354
Lobster	500
Oysters	6
Shell fish	40
Fish meal	1
Skin of polar bears	0·1
„ seals	229
„ walrus	37
„ dolphins	18
Tusk of walrus	0·1
Whalebones	17
Roe of codfish	6,330
Sounds of fish	21
Fish guano	8,344
Fat of seals and whales	602
Spermaceti oil	43
Medicinal cod-liver oil—	
Steam refined	882
Natural	1,164
Bright cod-liver oil	1,839
Pale brown cod-liver oil	2,898
Brown cod-liver oil	4,004
Other kinds of fish oil	827
Footing of fish oil	165

(Based on *International Fisheries Exhibition Literature*, 1883, Vol. V, Pt. II, F. M. Wallem, p. 27)

polymerised oil (*Sildoil*) which is light in colour and practically flavourless; it has not the quality of olive oil but it can nevertheless compete with soya and cotton-seed oils which are the chief substitutes for the more expensive olive oil.

Traffic in fish and fish-products has for many centuries been a staple trade of Norway and both the variety and the quantities involved are astonishing. The table opposite demonstrates the scale of operations in 1881 before modern techniques had been introduced and reveals the then value to Norway of this ancient industry. Its modern developments are considered elsewhere (p. 411 *et seq.*).

MERCANTILE MARINE

In Norway, which has a sea frontier of some 1,700 miles (2,720 km.), the sea unites rather than divides, and there is a great interest in marine activity. Though this has resulted in the growth of shipbuilding and engineering industries, the output of the yards is incommensurate with the size of the mercantile marine; naturally the principal centres are near the larger ports. Norway has developed her merchant fleet since about 1850, i.e. after the repeal of the Navigation Acts in Britain. At first she was aided by the supplies of timber for ship construction, but in the 1880s, when the wooden sailer was doomed, her lack of iron and coal meant that she could not then build a modern fleet in her own yards. Early in the present century the shipowners commenced to create a fleet of steam and motor ships, and it was then that Oslo first exceeded Bergen as regards tonnage registered. Despite the setback of losing 49 per cent of her tonnage between 1914 and 1918, a loss not compensated for by the high freights received, Norway had in 1938 the fourth largest merchant fleet in the world. In the Second World War, nearly half the fleet was sunk, but these losses were more than replaced by 1950 and the merchant fleet now comprises over 3,000 ships of about 12 million gross tons. This represents a greater tonnage per head of the population than is to be found in any other country. A feature of the fleet is the number of specialist craft, which may but rarely touch Norwegian shores; whalers, fruit-carriers, ore-carriers and oil-tankers.[1] This fleet has been a valuable earner of foreign currency and its earnings pay for one-third of the imports.

The story of the mercantile fleet of Oslo may be examined in more

[1] Since the war the fruit-trade has been particularly hit by currency restrictions and so the fleet of fruit-carriers has declined. Norwegian shipowners are ordering larger oil-tankers and in 1954 there were 34 tankers, each exceeding 20,000 d.w. tons, and by 1960 this number had not quite doubled, despite expectations. At 15 per cent Norway has not maintained her proportion of the world's tanker fleet as before the war, namely 18 per cent.

detail both on account of its importance and because it serves to illustrate the factors which influenced the acquisition of the vast fleet of modern Norway. There are many records showing the ancient interest in shipping: for example, in 1221 the Abbot of Hovedöya monastery sent a vessel with furs and skins to Lynn in Norfolk. In the thirteenth century, however, the German merchants, members of the Hansa, obtained control of Norwegian trade with Bergen as their centre, and it was not until the sixteenth century, with the rise of the Dutch traders, who hired Norwegian seamen, that the local interest in shipping revived. Along the small rapids of the Akers waterway sawmills were built and using this timber craft were constructed at the small creek, but the shipping activity of Oslo was long subordinate to that of Bergen. Unfortunately, the bankruptcy of the State in 1813, coupled with disastrous fires in the shipyards and the raising of the duty against Scandinavian timber entering the British market, particularly damaged the Oslo shipping industry. This setback was, however, followed by unprecedented growth in the fifty years after 1826, and by 1879 Norway, with a fleet of 1·5 million net tons, had the third largest mercantile marine in the world; but the proportion belonging to Oslo was still less than that of Bergen. Towards the close of the last century British shipowners replaced their sailing ships by steamships and Oslo merchants purchased the discarded vessels for the southern hemisphere timber, coal and grain trades. Then, for the first time, Oslo possessed a larger fleet than Bergen, but since the efficiency of a sailing ship was regarded as less than one-third that of a steamship of equal tonnage, and Bergen possessed more steamships than the capital, a tonnage comparison alone is invalid. In the first half of the present century the Oslo fleet has been greatly expanded; in the inter-war years there were, on an average, four new shipping companies established each year in Oslo. The steamship, with all that it represents in greater capital and the demand to have access to banks and insurance offices and to commercial houses to obtain cargoes to keep the vessels in as full employment as possible, needs the financial resources of a company and not of an individual and for this the capital city possesses more advantages than smaller centres. To-day the Oslo fleet not merely exceeds that of the other Scandinavian ports but it has a tonnage greater than that of the Danish and Swedish merchant fleets combined.

INTERNAL TRANSPORT: ROADS

With a scattered population, a difficult terrain and the great latitudinal extent, transport is an expensive problem in Norway. Road construction is difficult in the mountain regions. In the boggy

areas in particular detours are frequent and, traditionally, routes were shorter in winter as sledges were drawn over the frozen bogs and lakes. The oldest road suitable for wheeled vehicles was that from the Kongsberg silver mine to the shipment point on the Drammen river which was constructed between 1625 and 1630. About a century ago certain standards of construction were laid down, with maximum gradients of 1:12 or 1:15 and adequate widths. As a result the cost of transport was greatly reduced for the load drawn by a horse on the new roads was over ten times greater than that carried by a pack-horse on the old bridle-paths. Thomas Bennett, an Englishman, went to Norway in 1848 and introduced cabs in Oslo and stage-coaches in the country and through his tourist agency business stimulated the construction of better roads. Road construction in this country is expensive: ice-scraped rock surfaces need blasting, bridges must be frequent and the length of road must be great to get workable gradients up to the plateaux between the inhabited valleys. One of the most spectacular roads in Norway is that from Årdal, beside Sognefjord, which ascends the valley wall in 44 great loops.

Traditionally each man was responsible for a section of road, but maintenance is now in the hands of the State or of the parishes. Roads are now kept passable for longer in winter by the provision of snowploughs and by the introduction of snow-screens and of wire-fences to reduce drifting. More difficulty is experienced in keeping the western roads open as the wet snow there is more difficult to remove than the dry powdery snow of the east. The improvement of winter communications has resulted in a decline in the self-sufficiency of the hamlets and homesteads. One consequence of the former dependence upon waterways was the creating of administrative boundaries to embrace territories served by a waterway, and with the growing significance of motor-roads a few boundaries have had to be revised so that lakes and fjords have become dividers, instead of uniters, of districts.

RAILWAYS

The rugged mountainous terrain and hard winters are also obstacles to the construction and operation of railways but the long distances between important centres encourage the provision of railroads. At first railways were constructed by private companies but before the end of the nineteenth century the State had purchased the main lines and left only local lines to private enterprise. Many difficulties have had to be overcome in constructing the railways, particularly on the Bergen line, which has 184 tunnels with an

aggregate length of 24 miles (38·4 km.) in the 306 miles (492 km.) between Bergen and Oslo as well as lengthy snowsheds in the section crossing Tågevatn "summit" (4,268 ft., 1,301 m.) on the flat mountain expanse from Myrdal to Geilo. The first railway constructed in Norway was that opened in 1854 through the gap east from Oslo into the lower Glommen valley at Eidsvold; it was built to the plans of the eminent English engineer, Robert Stephenson and was partly financed by British capital.

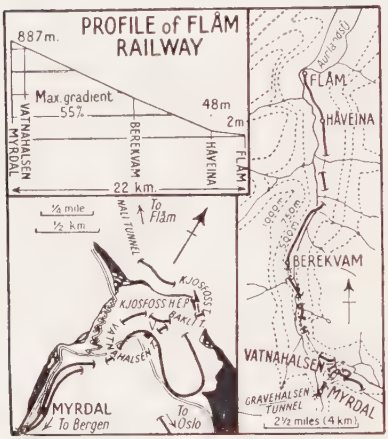


FIG. 86.—ROAD AND RAILWAY LOOPS MYRDAL TO FLÅM.

The contortions of the road and railway, to overcome the altitude difference of over 2,800 ft. (850 m.) between the two places which are only 9 miles (14 km.) apart, are clearly seen in the left-hand diagram.

Based, by permission, on map of Flåm Railway in *Railway Magazine*, 1940, p. 365, *Grafisk rutebok*, Nr. 99, Plate 9 and sketch contours from German military map, 1:250,000.

In the construction of the railways through Gudbrandsdal and Österdal in the late nineteenth century the lines were kept to the valley floor. In the narrow portions of the former valley it was difficult to find station sites which were not liable to flooding and so the stations have been placed near the apex of the deltas of the larger tributaries as, for example, at Otta; these sites have the further advantage of permitting the side valley to be served, while the deltas narrow the main river and facilitate bridging. The new railway towns have thus attracted traffic from the older market centres; for example Otta has grown at the expense of Vogomo, as well as accommodating the modern tourist traffic. The construction of the trunk lines bound the country together; the Østerdalen line opened in 1877 reduced the travelling distance between Oslo and Trondheim of 793 nautical miles (1,467 km.) by sea to 349 statute miles (562 km.) by rail, though at first there was a change of gauge at Hamar, while the opening of the Bergen line in 1907 brought the distance down from 423 nautical miles (783 km.) to 306 statute miles (492 km.) by rail and the time on the journey to one-third. During the Second World War the long-projected Sørlandsbanen was completed between Stavanger and Oslo and the northern railway was continued towards Bodø—by 1960 it reached Fauske. Since the war a Commission has been enquiring into the choice of new lines for construction with the

limited financial resources available, and the analysis made of conditions is a valuable review of Norwegian rail transport. Unfortunately the existing railways need to be subsidised even before interest can be paid on capital borrowings. Electrification of main-line railways commenced in 1922 and by 1949 about one-fifth of the State Railway mileage, handling 45 per cent of the traffic, was electrified; it is anticipated that when 30 per cent of the mileage is electrified 60 per cent of the traffic will be hauled electrically. In 1960 one-quarter of the mileage was electrified. Air transport has been developed for passenger traffic but the rugged relief and maritime climate are about the worst in Europe for aircraft operation.

Photograph by courtesy of S. H. Beaver] [*August, 1951*

FIG. 87.—VESSELS USING THE INNER LEAD NEAR BERGEN.

INLAND AND COASTWISE SHIPPING

Norway has numerous lakes and rivers but the use of the latter for navigation is limited by the many rapids and waterfalls while the

hard winters have discouraged the provision of canals. The three principal canals are the Fredrikshald Canal, 47 miles (75 km.) long, opened in 1877 for vessels of 5·6 ft. (1·7 m.) draught, the Nordsjö–Skien Canal, opened in 1861, and the Bandak–Nordsjö Canal of 65 miles (104 km.) opened in 1892. Traffic is limited and the main uses of these canals are now for timber floating and also for tourist traffic, for the Bandak–Nordsjö Canal, in particular, passes through a most attractive region.

Although Norway has such a long land frontier the traffic flowing across it, to and from Sweden or beyond, is relatively slight and the most important trading entry is still by sea. The coastwise traffic, encouraged by the shelter afforded by the skjærgård over so much of the coast, was revolutionised by the introduction of steamships from 1827. In 1893 the *Hurtigrut* (Express Coastal Route) was opened which reduced the time for the Trondheim–Hammerfest journey from $6\frac{1}{2}$ to $2\frac{1}{2}$ days. The routes to minor settlements have to be subsidised, but on the main routes tourist traffic adds greatly to the revenue.

COMMERCE

Commerce has long been a feature of Norwegian life and a treaty of 1217 between Norway and England is one of the oldest English commercial treaties. Even before the settlement of the Hanseatic trading group in Bergen the town was known for its commercial activities. Bergen was dominated by Lübeck merchants from the fourteenth century but their control was finally broken in 1560 with the increase of Dutch trading activity with Norway. "The Commodities which it yields fit for Exportation are Timber of all kinds, expecially Firr; Stock fish, Masts for Ships and Iron, of these it has a tolerable Store; most of which the *English* and *Dutch* purchase yearly with ready Money: And herein *Norway* exceeds the other Dominions of the King of *Denmark*, that it affords Comodities for Exportation, which none of the rest do in any quantity."[1] The staples long remained constant, but by the late eighteenth century much of the trade was in the hands of Norwegians. The export trade grew on the sale of fish, timber and copper and the value of the exports balanced that of the imports. During famine years it was necessary to import grain from Denmark. Trade flourished until 1807, when Norway was drawn into the Napoleonic Wars and commerce did not recover properly until the 1830s. In the eighteenth century the export of timber had been principally to the Netherlands and Britain, but in the nineteenth century the principal

[1] Ifvar Kraak, *English Grammar*, 1748, quoted by P. Tennant, p. 18.

consumer was France. In the second half of the nineteenth century the foreign trade of Norway more than quadrupled, with imports increasing more rapidly than exports partly because of the breakdown of subsistence farming and partly because of the need to import raw materials for the expanding industrial activity. However, the Free Trade Policy of Britain was a stimulus to Norwegian suppliers. At the close of the nineteenth century timber and fish products were still the staples, as they had been for centuries.

Until the Second World War trade was relatively free from controls but now imports are restricted to essentials after the disastrous disruption during the Occupation. The exports still consist of timber and its products, fish and whale products, artificial fertilisers, ores and metals. The United Kingdom for long has been the principal consumer of Norwegian goods and the principal supplier of imports.

REGIONS OF NORWAY

Norway can be divided into five regions which, while not homogeneous, nevertheless have sufficient community of interest to present a theme of human activity which justifies the linkage of one district with another. The regional classification adopted here is as follows:

Northern Norway	Sørland
Trondheim region	Østland
Vestland	

NORTHERN NORWAY

North of 65° and of the Folla break in the Inner Lead commences what may be regarded as Northern Norway. Three-quarters of this region lies north of the Arctic Circle but although the conditions of life are rigorous they are better than the average for the latitude. This is the most northerly extension in the world of population in any considerable numbers; the advance of settlement northwards has taken place in relatively modern times. Even a thousand years ago this territory was not without resources: seals, whales, cod and herring provided food and trading items, the prolific bird-life gave down and eggs, while furs were a valuable export which helped to pay for the corn imports needed to supplement the meagre crops.

This vast territory can be divided into five parts: in the north is the plateau of Finnmark, and the area south-west of this shows a fourfold longitudinal division into skjærgård and strandflat, coastal mountains, comprising a number of different ranges, lowlands and then the mountain upland known as Kjølen. This longitudinal division persists as far north as Ofotfjord but there are deviations

such as partial drowning which has turned the lowlands into marine channels and the coastal mountains into islands. Transverse valleys are infrequent south of Troms amt; the more important are those used by the railways to the Sulitjelma copper mines and to the Swedish iron mines of Lapland. North of Ofotfjord the longitudinal division tends to disappear and there are several transverse valleys which link with those of Sweden. The present watershed between the drainage towards the Atlantic and that towards the Gulf of Bothnia is sometimes no more than a slight rise in elevation, for during the Ice Age the drainage parting lay temporarily to the east; for example, the Swedish lake called Torneträsk was dammed by an ice-mass to the east and the overflow for a time found a westward outlet by Bardudalen and Sørdalen.

The skjærgård and strandflat belt, here composed of Caledonian mountain-range limestones and mica-schists, attains its greatest breadth of some 28 miles (45 km.) in the south, where the edge of the continental shelf is 175 miles (280 km.) from the shore. Rising behind the strandflat are peaks of more resistant gneiss, granite and gabbro, of which the most famous, though not the highest, is Torghatten, 879 ft. (268 m.). The lowland areas of the valleys are carved out of schists and limestones and to the east of these rises Kjølen which is high and barren and still bears icefields.

In the north the Norwegians early laid claim to all unoccupied territory and taxed the nomadic Lapps whose territories had already been reduced by the ingress of Norwegians, Swedes, Russians, Finns and Karelians. The clash of interests which resulted became intensified when the activities of the Hanseatic League expanded the market for stockfish and caused Norwegians to move north to tap new fishing grounds. In the fourteenth century the early Norwegian settlements were much harassed by Russian raiders and so later colonisation into Finmark proceeded slowly.

1520 . .	1,800 Norwegians
1597 . .	2,830
1619 . .	2,650
1679 . .	2,070

The slow decline was due to poor trading conditions with rising cost of imported corn and diminishing prices for fish after the Reformation. The 1690s were, as in Scotland, years of famine when both the fisheries and the harvests failed. Markets were established at which the Lapps from Norway, Sweden and Finland bartered goods, and the greatest of these markets was at Bossekop, situated at the head of Altafjord. These markets were invaluable for the development of the area, as they opened avenues of supply other than by the coastal traders, since merchants also came in from Torneå.

Finnmark

Finnmark proper commences at Altafjord, which coincides with the widening of Norwegian territory to 250 miles (400 km.). It is a region of plateau some 1,000–1,650 ft. (300–500 m.) in elevation, rising gently to the watershed; there are numerous upstanding summits of which the highest is Rastegaisa, 3,543 ft. (1,080 m.). This plateau consists of ancient grits, quartzite and gneiss. The monotony of the relief is emphasised by the uniform tundra cover of lichens, mosses and dwarf willows which occur even on the marine deposits exposed on the raised beaches by an uplift of some 262 ft.

A.C.O.] [*August, 1955*

FIG. 88.—PROTECTION AGAINST AVALANCHES AT HAMMERFEST.

Although the hill behind Hammerfest is not high the slope, owing to aspect, is liable to avalanches and as the town has to be built on a narrow apron close to the slope protective fences have been provided.

(80 m.). The coastal edge of the plateau is a series of low, but abrupt, cliffs and there is no protecting skjærgård. The fjords which enter the land are large (Porsangerfjord is 65 miles (104 km.) long), but of simple plan and wide and monotonous, lacking the beauty of the mountain-rimmed fjords of farther south. Finnmark has a drier and more polar climate than the rest of Norway: at Alta the mean January temperature is 17·6° F. (−8° C.). Lacking coastal mountain ranges it is exposed to strong winds, which, owing to the change of direction of the coast, do not flow first over very warm seas, and tree growth is inhibited except in open, gently sloping valleys and at

the heads of the large fjords. Such agriculture as occurs is limited to the marine terraces: potatoes are grown and cereals sown for a green fodder crop. The region was originally administered from Hammerfest, the most northerly established town in the world,[1] which has been a trading centre for centuries. In the interior of this region live Finns (in Vadsø and Alta districts) and Lapps, some of the latter practising reindeer transhumance, while on the coastal lands are farmer-fishermen, Lapps and Norwegians, who fish from April to June for capelin and cod. When sea temperatures are low the spring cod fishery is inshore but in warmer seasons the cod can only be caught from larger fishing vessels. Many foreign trawlers fish on the submarine platform off Finnmark. Before the Revolution Russian traders from the shore of the White Sea used to bring flour and timber to trade for Finnmark saltfish. With rivers too turbulent for easy navigation, communications overland are poor although a road now runs from Altafjord to Kirkenes. Since 1906 the low-grade magnetite-taconite iron-ore of Sydvaranger (Sør-Varanger) has been exploited and has, on occasion, employed as many as 1,600 in the mining and concentration of the ore. The peak output was 600,000 tons of concentrate in 1915 but coal shortages and the post-war depression reduced the output. The mines and the loading plant were wrecked by air attacks from both sides but have been reconstructed for an annual output of one million tons of concentrate. This is the most valuable of the ore deposits and is worked by the largest mining company in Norway. The copper ores of the Raipas and Porsanger districts have only occasionally been worked. There are possible sites for hydro-electricity production but only a few have been developed and most power is obtained from the thermal station at Kirkenes. Finnmark is a land of difficulty and the pattern of life became stark in the closing stages of the German occupation when most of the settlements were destroyed by a "scorched-earth" policy. The absence of sun in winter tends to bring about nostalgia and melancholia; some people like the environment but it leads others to madness, an effect noted among the occupation forces.

Lofoten Islands

Hinnøy and the Lofoten Islands run as a great rampart of peaks south-westwards from the mainland, and, with the Vesterålen group to the north, lie on the submarine ridge separating Vestfjord from the North Atlantic. The Lofoten Islands rise sharply from the

[1] Since the war the fishing centre of Honningsvåg, nearly a degree further north, has been given some status for it is the trading centre of the north. The administrative capital of Finnmark is Vadsø.

fishing banks to 3,392 ft. (1,034 m.) in Moskenesoy and 4,153 ft. (1,266 m.) in Hinnoy, and have been named Lofotveggen ("the Lofoten Wall"). They offer little soil for agriculture except in Vestvågoy, but they do support a small livestock industry. The high land is deeply dissected, bare rock and useless, for during the last glacial period Lofoten had its independent ice-cap and this actively eroded the terrain and sharpened the relief with peaks and corries. Parts of Hinnoy and the Vesteralen group are lower and more fertile, and here, although much of the flat land is boggy, fishing tends to be subordinate to farming. Peat is used for fuel while seaweed,

A.C.O.] *[July, 1932*

FIG. 89.—FARMING IN THE LOFOTEN ISLANDS.

Arable land is very limited and ploughing is restricted to small patches such as this near Lødingen.

besides providing a source of iodine, is used for cattle fodder to help meet the eternal demand of these northern latitudes — the supply of bulk feeding-stuffs.

In this area it is impossible to have a combination of fishing and farming on any large scale, for the land resources are too limited and the great numbers of fishermen required come for the season from their homes further south or from the northern ports. The "Domesday Book" of the Archbishop of Trondheim, compiled in 1434, reveals that in the north there was no house more than two English miles (3¼ km.) from salt water and few settlers lived up the fjords but that there were considerable fishing settlements at Vesterålen. The

many creeks favoured exploitation of these rich fishery grounds, but before the days of power-driven craft, the numerous tidal races, the most notorious being Moskenes strømmen, were a serious danger. Along the strandflat of Vestfjord are huddled the numerous wooden huts and fishing stations; the northern waters off Lofoten are less valuable for fishing. About the middle of February the cod, between six and fourteen years old, begin to leave the Barents Sea and move into shallower water to spawn, in enormous shoals which are sometimes 150 ft. (45 m.) thick and so close that a sounding-lead will not pass through them. They are the prey of as many as 25,000 fishermen from Lofoten fishing stations, who have been known to catch, in one season of under four months, a hundred million cod; in recent years the catch is about 80,000 tons annually although it varies considerably from year to year. There are three methods of fishing off the Lofoten Islands. nets, long lines and (now less used) hand-lines. From 1949 there has been a revolution in technique with the introduction of the seine-net. Formerly the fishing boats retained the traditional Northland style but now they have been largely replaced by larger motorised craft for net fishing. Along with this modernisation of the craft has been the provision of better navigational aids. On the shore besides the stances for drying the *stockfisk* is the plant for preparing cod-liver oil and meal as well as the plant for freezing part of the catch. The principal centres for this intensive, but short-lived, activity are Svolvær, Harstad and Henningsvær. This last is a remarkable village development on a group of islands conveniently situated for the fishing banks; its main street is a sea channel and the fresh water supply has to be drawn from Austvågøy. The problems of this fishery are many, for the catch could be obtained with fewer men, and the toll in ill-health and by drowning is considerable, but the industry employs men with small holdings elsewhere. Government plans for the nationalisation of the industry are in existence, but the loss of a source of income to men from the south, if the fisheries are to be pursued by whole-time fishermen only raises fresh problems.

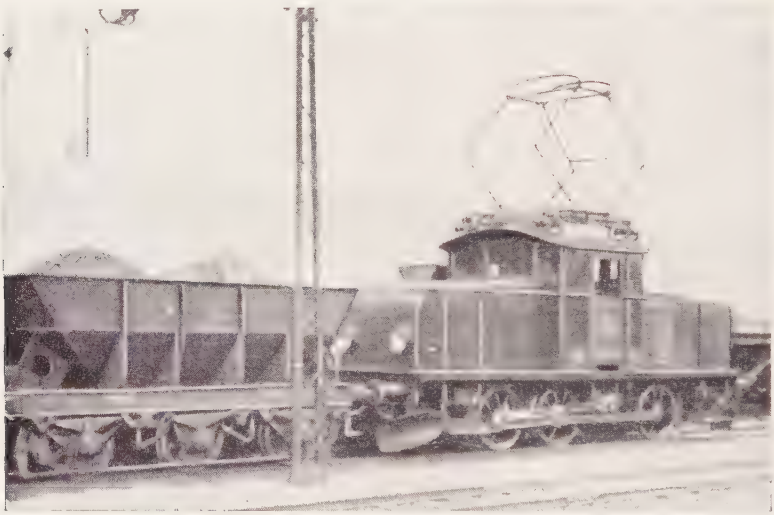
Troms and Nordland

On the mainland south of Finnmark cultivation is limited to the clay-covered portions of the strandflat or to the bottoms of the interior valleys, with barley and potatoes and livestock as the staples. The income from many of these small farms is too small to support the population and the income is supplemented by fishing and forestry activities. Coniferous trees are only found in the inland valleys and birch is the main tree in the woods, the upper limit of

which is much lower than in the south. Despite its inhospitable aspect much of this part of Northern Norway has been peopled since the Stone Age. Into the Saltdal district Swedish Lapps migrate with their reindeer in summer and these people have given their Lapp names to a number of topographical features. For long the Northland was a source of furs and fish but the prosperity built on this was destroyed in the thirteenth century by the law which demanded that all fish had to be sent south to the merchants of Bergen; apart from the monopoly so created the long journey south was a waste of time for the northerners and prevented them from working their holdings. In the view of some writers, Bergen merchants did not unduly abuse their monopoly for while they controlled prices they did supply credit to the fishermen in poor seasons. The rise of the Newfoundland fisheries and the spread of the Reformation, which reduced the demand for Norwegian fish, further damaged the flow of trade. Fishermen in the Troms province were forced to migrate inland and, after clearing forests, advanced the agricultural limit nearer the pole. Even when liberty of trade was finally granted in 1787 it did not bring immediate prosperity for the climate is not ideal for drying fish and salt supplies had to come from the south—from France and Iberia. After this epoch, marked by famines and a decline of population, the north commenced, from the end of the eighteenth century, to re-develop through colonisation by people from the mountains of Østland. Settlers from Trøndelag and Østland settled in the Bardu and Målselv valleys after 1789, and in these open valleys, set in forestland, crops grow well. Nevertheless, it was from these northern colonising areas that the first major Norwegian emigration flow to North America went, possibly because the settlers had not yet identified themselves with the district. Many Finns have entered Troms province by Skibotn during wars and famine years, but the greatest influx from northern Finland in 1865–1868 was of folk who were virile pioneer settlers in the district of Lyngen. In the Lapp area north of Trondheim the frontier with Sweden was delimited in 1751, but the frontier with Russia was not demarcated until 1826 for the tongue of tundra extending southwards along the mountains offered little to settlers, who preferred to keep to clearings in the forest. The later colonisations, however, displaced the Lapps, who valued the summer grazings for reindeer. They have led to an increasing interest in the north; in 1801 under one in ten Norwegians lived north of 65° N., and in 1960, despite the abnormal pull of Oslo, the proportion remained one in ten. These changes were brought about by the concession in 1857 of the right of all Norwegians to fish on the Lofoten bank, the acceleration of communications by steamships (the first steamship ran to the north in

1838) and by improved fishing technique. However, until the railway from Trondheim is extended northwards from its present terminus at Lønsdal, the coastal towns of the north cannot develop greatly, for they remain isolated.

Along the coast there are numerous fishing and trading communities. Of these Tromsø is one of the most favoured; founded in 1794, it displaced the ancient trading site of Bentsfjord, and is to-day a regional centre with vessels trading not only along the coast but also, since 1850, to Spitsbergen and the northern fishing grounds. The export trade in stockfish to the Mediterranean redeveloped from Tromsø after the Napoleonic Wars, as did traffic in general to Russia.



A.C.O.] [*July, 1932*

FIG. 90.—NARVIK IRON-ORE QUAY.
Electric locomotive shunting iron-ore wagons at Narvik.

The growth of the town was affected by heavy emigration to Canada and, to a much smaller degree, to Australasia, in the 1860s and 1870s.

Bodø was established as a trading town in 1811 but did not prosper until herring shoals moved into local waters in 1864 and the town grew rapidly from a population which numbered only 228 in 1855. The establishment of the Sulitjelma copper smelter in 1887 further stimulated growth of Bodø. Narvik,[1] selected as the site of a

[1] The British company gave the name Viktoriahavn to the harbour, but when the project was adopted by the Norwegian government the farm name of Narvik was used.

landing place at the head of Ofotfjord to serve the winter needs of the Swedish Lapland iron fields (which only became valuable after the invention of the Thomas "basic process" of steel-making in 1878), has grown quickly; when the site of the railway terminal was selected in the 1880s by a British railway concession company it was a small township of 50 inhabitants but by 1960 the population was over 13,000. A small quantity of fresh fish from Lofoten is taken from Narvik and distributed by the Swedish State Railway system.

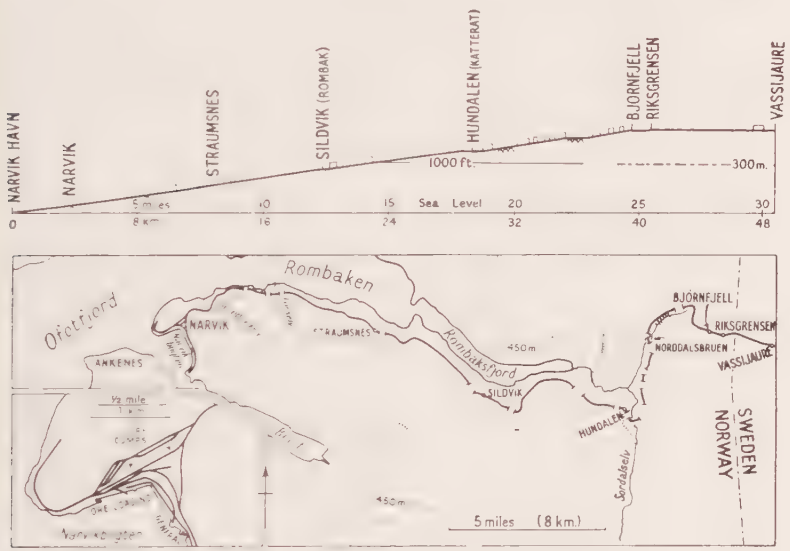


FIG. 91.—THE OFOT RAILWAY AND SITE OF NARVIK.

This map locates the route of the railway with inset the details of the port of Narvik; the profile of the railway has the tunnels marked above the profile and bridges by ∧ below. As this is a single-track route trains can only cross at passing loops.

Based on profile of line in *Nor. Stats. Ban., Grafisk Rutebok*, No. 99, 1950.

Scattered through the north are a number of resources which supplement the fishing and poor agriculture. The worked mineral deposits include pyrites in Dunderlandsdal, behind Mo, at Sulitjelma and Bjorkasen (west of Narvik); these ore-bodies are mined for their sulphur, copper and zinc content. The ore body at Sulitjelma is found as elongated lodes; the mined ore is conveyed to the smelter by an aerial rope-way. There is a short narrow-gauge railway from the mines to the nearby lake which completes the transport link: in winter transport goes on by lorries across the ice but the railway is

being extended down to salt-water. While there are many deposits of magnetitic and hæmatitic iron-ore, the quantities and iron content did not lead to the early establishment of industry. Now, however, the new iron-works of Mo i Rana will use the magnetite-hæmatites of Dunderlandsdalen. Some water-power has been developed although the head of the water is low; the chief exception is at Glomfjord

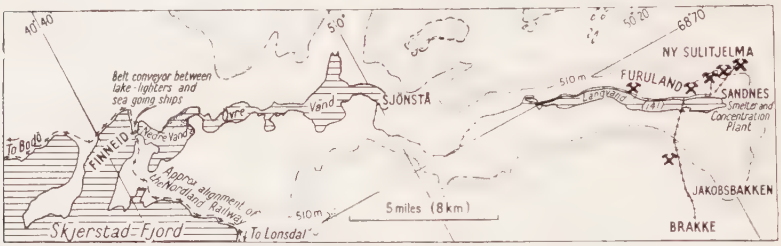


FIG. 92.—ORE TRANSPORT FROM SULITJELMA.

This involved transport system is to be replaced by the construction of a standard gauge branch from the Lønsdal–Bodø extension.

Based on T. Sund and A. Sømme, *op. cit.*, Fig. 66 and 1:100,000 map Saltdal, L. 13, 1942.

1,510 ft. (460 m.), used by the former Haugvik aluminium works and now for the ammonia plant of the Norwegian Nitrate Company. Sulitjelma uses hydro-electricity for concentrating and smelting the ores at Langvandet; unfortunately the fumes from this plant have destroyed the vegetation over a wide area. Another mineral resource is marble and this has been quarried extensively at Fauske (Saltdal).

TRONDHEIM REGION

Round Trondheim fjord and extending northwards into Namdal, is an area of lower ground marking the presence of Silurian schists and limestones. Trøndelag is a rich district and has many features similar to Østland—the open valleys, the forests, the pattern of settlement—but differs in its maritime character. Between here and the Baltic the ridges do not exceed 4,100 ft. (1,250 m.) while round the main fjord most of the land is below 820 ft. (250 m.). It is only on the south that really high land occurs in Dovrefjell. On the west are coastal highlands but although these are high they are broken in several places and this allows mild, south-west maritime influences to penetrate and so counterbalance the easy ingress of northerly winds. The Trondheim depression thus owes its main character to the combination of lower land and maritime influences. This region stands out in sharp contrast with Northern Norway for it is the

northernmost part of the country where fishing is subordinated to agriculture. Also, although on the fringe of the northern lands, the region is not isolated in the same way, for it is linked by routeways along the large valleys to the north, the east and the south.

Unlike settlement in Vestland the coastal zone here is less settled than the inner fjord region. Post-glacial uplift raised marine deposits some 650 ft. (200 m.) and the terraces of these deposits provide, in conjunction with the morainic deposits formed from the Cambro-Silurian rocks, the basis of the soils which have been long used for an agriculture based on barley cultivation and the rearing of cattle. In the interfluve hills sæter pastures occur above the upper limit of trees at about 1,640 ft. (500 m.) but many of them are now abandoned. In this region where there are many clay deposits, spruce is dominant, except in the upper zones of the forests where pine and birch flourish. These forests, like those of Vestland, are not now found growing close to the coast but provide a less accessible resource for the future. Mining also occurs and there are several

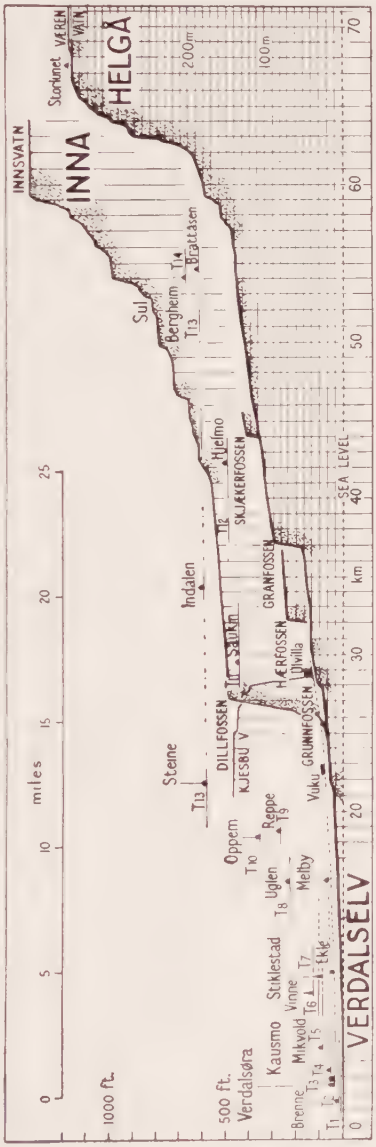


FIG. 93.—LONGITUDINAL PROFILES IN VERDAL.

The vertical exaggeration is 1 : 50. Note the way that the rock outcrops are responsible for breaks of slope in the thalwegs and the influence terraces have on settlement.

Based on diagrams supplied by *Norges Vassdragsvesnet*. Terraces from field observations by Aberdeen University Verdal Expedition, 1953.

W.
E.
3000 ft.
2000 ft.
Helga
Hegvold
GULA SERIES
(Brown Mica Schists)
Green Mica Schists Limestone
Grey Mica Schists Gabbro
Hærvolas Granite
CAMBRO-SILURIAN ROCKS
Quaternary Deposits
Greenstone
Gneiss
Quartzporphyry
KOLI THRUST
Rensjön
SEVE
(Amphibolite Mica Schists)
0 1 2 3 4 5 6 7 8 9 10 11
MILES

FIG. 94.—VERDAL.

The upper map shows the complexity of the solid geology in the thrust zone with the intrusion of igneous material and the metamorphism of the rocks. The lower map shows the extent of the two main erosion surfaces and the various glacial and marine features which have modulated the surface. For an account of the human geography of this area see W. Kirk and F. M. Synge, "Farms of Verdal, Norway", *Scot. Geog. Mag.* 1954, pp. 106–23.

Based on P. A. Oyen, O. Holtedahl, I. Undas, O. Ängeby, J. P. Friis, A. G. Högbom, G. Holmsen, A. E. Tornebohm, etc. Base maps Topog. Kart Norge 1:100,000 Rektangel 50A and B and Svenska Fjällkartan, 1:100,000 Blad 9.

pyrites mines working near Trondheim; the oldest working was at Røros to the south-east, in the headwaters of the Glomma valley, and the largest now operating in Norway is at Løkken in Orkladal whence the pyrites is carried by electrified railway to Thamshavn for treatment along with imported concentrates. The Røros copper was developed in the early seventeenth century, using immigrant German miners. The only recent working of zinc-lead in Norway was at Rana and the smelting plant supplements the local supply by imports. Near the northern end of Trondheimfjord magnetic iron ore is worked while from Romsdal titaniferous iron ore is obtained. Ferro-alloys are produced electrically at Ila and Lilleby and at Meråker. The extensive clay deposits are used for brickmaking and the limestone bands for lime-burning.

Since the Middle Ages Trondheim has been a regional centre. The port is situated at the mouth of the river Nid on the fragments of four deltaic surfaces which rise to about 200 ft. (60 m.) above the present sea-level; it is near the entrance to the fjord where it can tap the northern fisheries and at the same time it is at a convergence of land routes. On it now focus railways from Sweden (*via* Jämtland and Stjördal), from the south (*via* upper Gudbrandsdal and *via* Østerdal) and from the north (*via* Namdal). These assets have been added to the wealth of the rich farmlands which surround the town. At the date of its foundation in 997, when the peninsular site was selected for defensive reasons, Trondheim was made a city. Its cathedral was modelled in the twelfth century on Canterbury, and it became an archbishopric in 1153; it remains the spiritual heart of Norway. After a chequered history, including repeated destruction by fire like so many of the cities of Scandinavia which were built of wood, the town has acquired modern industries; it is a pioneer centre in Norway for the quick freezing of fish fillets and has an increasing population, although the surrounding rural districts are showing signs of a decline.

Outside the Trondheim depression but connected with it is the district of More and Romsdal, which is on the northern fringe of Vestland and forms a transition between it and Trøndelag—Northern Norway. The general level of the great Dovre plateau is some 3,000–4,000 ft. (1,000–1,200 m.) although the highest individual summit attains 7,370 ft. (2,247 m.); but along its edge there has been deep incision and there are few relics of the palæozoic peneplane, with the result that it appears more as a region of peaks known as "Alps". From the highest land the plateau surface drops north-west to the sea and ultimately only the summits of the massif stand above water and the drowned glaciated valleys form fjords and channels which provide some of the most magnificent coastal scenery of Norway. Geiranger

is the most popular tourist district in the whole country. While most of the islands represent such drowned summits there is along the coast, west of Ålesund, a chain of small islands which represent the top of a vast, submarine terminal moraine. Recent uplift of some 500 ft. (150 m.) has created a strandflat on which settlement is concentrated.

Møre is less rainy than Vestland and has a very mild climate on account of the deep penetration of salt-water fjords and the shelter given by the angular bends of the fjord pattern. The mountains of Sunnmøre have a bad reputation for rock and snow avalanches and in 1934, for example, a rock avalanche slid into the fjord and caused great loss of life along Tafjord, where the 200 ft. (60 m.) high wave generated swept over the delta settlement. The fertile pastures round Molde and in Romsdal support a dairy industry and Romsdal is also a centre of sæter exploitation. Of far greater value than the land wealth is that of the sea where cod and herring are caught. Kristiansund, founded in the eighteenth century, destroyed by fire in 1909 and by bombing in 1940, has been rebuilt and is still a centre for the *klipfisk*, much of which is now dried by electric heaters, while Ålesund fishes for *skrei* (mature cod) and herring in spring and sends vessels to the whaling. This area of Møre and Romsdal was stimulated by the opening of the railway from Dombås to Åndalsnes in 1924: one rather unusual item of traffic used to be the transport in tank-wagons of live cod to Berlin.[1] (See Fig. 149, p. 420.)

VESTLAND

The coastal limits of this region are taken as Cap Stad on the north and Stavanger peninsula in the south, and inland it extends as far as the eastern edge of the high fjells. This coastal belt is backed by high mountains, with vast glaciers, and is deeply cut by fjords: Osterøy, north-east of Bergen, is the only Norwegian island encircled by the mainland. On account of its tourist traffic, attracted by the beauty of the fjords, it has become identified in many minds as the typical scenery of Norway. The high fjell formed of complex folded and overthrust rock appear as a plateau surface above which rise some former nunatak summits. The surface of the fjell is formed by the palæozoic peneplane and although the edges are deeply cut by the fjords and such deep eastern drainage straths as Valdres and Hallingdal most of the plateau-top valleys are shallow and have meandering streams dating from the pre-Tertiary uplift period. South of 61° the fjell appear as a monotonous plateau with blocks of even higher plateau country termed *vidder*. The *vidder*, the largest of which is

[1] This movement of live fish was also adopted on the Bergen railway.

Hardangervidda, have a dreary appearance with small rock basin lakes, peat-bogs, erratics, ice-scraped rock surfaces and patches of dwarf birch and willows, junipers and lichens; only in the drier east is an alpine flora found. In the Bronze Age, when the climate was milder, the tree-line reached higher up the slopes; a further factor in the lowering of this upper limit of trees has been the grazing of goats at the outfarms. The goats damaged the young trees while the preparation of goat's milk cheese used much fuel and with the loss of a ready fuel supply many of these upland pastures were abandoned. Ice-caps still exist, the largest being Foglefonn and Hardangerjøkel, but are diminishing in volume, particularly where most exposed to the sun. North of Sognefjord lies the great icefield of Jostedalsbreen (580 sq. miles: 1,500 sq. km.), which sends tongues into the surrounding valleys, but nowhere in southern Norway do the tongues approach sea-level as they do at Svartisen in Northern Norway. In August 1937 the ice-tongue forming Demmevatn, south-east of Ulvik, had shrunk sufficiently to float and in three and a half hours the lake emptied causing a flood disaster in Simadal and extending the delta of the Sima further into the fjord.

Jotunheimen, lying between the deep valleys of Ottadal, Gudbrandsdal and Valdres, is a higher plateau rising some 1,650–3,300 ft. (500–1,000 m.) above the plateaux of the south. Deep dissection by narrow valleys has given the plateau the appearance of high peak country and here is found the highest mountain of Norway and of northern Europe, Galdhøppigen, 8,097 ft. (2,468 m.). Jotunheimen was opened up less than a century ago as a tourist area and the name, which means "Home for the Giants", was coined by the well-known Norwegian author Aasmund Vinge (1818–70). Roads are gradually being provided and that across Sognefjell is the highest motor road in Norway, ascending to over 4,600 ft. (1,400 m.) above sea-level. In contrast, Dovrefjell is a plateau with bare peaks rising above the general surface and deep forested valleys cutting across the fjell. These valleys provide through routeways from Oslo to the coast of More, but many others end in corries (known in Norway as *botn*) which cause cul-de-sacs in the road pattern. Northwards lies the plateau of Trollheim; this is high and rocky in the south but drops northwards to a forested landscape. To the east is the lower plateau known as Rørosvidda.

Until the seventeenth century the only use of these fjell was for hunting but since then there has been a partial exploitation of the summer pastures. Long isolated, this great barrier of high plateau was first effectively crossed when the railway between Oslo and Bergen was opened in 1909. In the past cattle used to be driven between Hardanger and Ostland along trails. Near the head of

Sognefjord, Lærdalsøyri was a central focus for pack-horse routes connecting the west with the great eastern valleys and, with a yearly market, it became one of the most important villages of the region. Only at the present time are the last links being made in providing a direct road between the cities of Oslo and Bergen without a ferry-crossing of Hardangerfjord.

The coastal belt is distinguished by the development of strandflat and fjords which allow human occupation. The great fjords, abruptly cutting the fjell, offer a marked contrast in vegetation and human response both to the strandflat and to the high country. The valleys, submerged at their seaward end, have flat floors until

Photograph by courtesy of S. H. Beaver] [*August, 1933.*

FIG. 95.—VOSS.

This town is an important tourist centre and is unusual for a Norwegian rural centre in having a thirteenth-century stone church.

they are closed inland by great ramparts, over which rivers tumble and roads have to zig-zag, against the edge of the plateau. These cul-de-sac valleys are found all along the western coastal zones and all bear similar characteristics of glaciation and settlement. Where the larger side-valleys meet the main fjord valley there are generally a cluster of houses and a pier which act as a focal point. Some of the valleys are so deep that little insolation is received; for example, in Simadal at the head of Eidfjord, the valley floor does not get the direct rays of the sun for six months in the year. The steep sides of these valleys limit the extent of pasture and also cause rock and snow avalanches. The enlargement of the scree slope destroys farmsteads

and is a powerful factor in the limitation of settlement in the narrow valleys. Along Nordfjord the settlements of Nesdal and Bødal have been destroyed, with heavy loss of life, twice during the present century. Kjeåsen farm, north of the head of Simadalsfjord, is a well-known example of the difficulty of settlement for it is situated on a ledge 1,722 ft. (525 m.) above sea-level, and can only be reached from the shore by ladders.

These fjord valleys resemble the interior valleys in the warmth of their summers, but they have the advantage of not experiencing the extreme severity of the winters, for in most years the deep fjord

Photograph by courtesy of S. H. Beaver] [*August, 1933*

FIG. 96.—NÆRØ VALLEY FROM STALHEIM HOTEL.

The valley floor lies 1,000 ft. below the viewpoint and the road has many hairpins to ascend.

waters do not freeze. Although the spring begins earlier than in eastern Norway it is often cool and cloudy with the result that the snow melts late and, with farming unable to be carried on at any great height, few hamlets occur above 1,000 ft. (300 m.). An interesting practice at some of the high hamlets has been the strewing of earth over the snow mantling fields so as to increase the absorption rate of insolation and thereby increase the rate of snowmelt.

Only on the valley floors and on the less steep sides of the valleys do trees grow; spruce is rarely found and pine is dominant, with oak, ash, elm and maple on south-facing slopes. Much depends upon the exposures and even the conifers are not found close to the

exposed coast and in this zone the upper limit of tree-growth is low. Above the tree-line, pastures are used for sæters but this traditional use is falling into desuetude owing to inadequate communications which have been accentuated in their effect by the development of mechanised road transport. The vegetation is very variable with aspect and it is noticeable that the alignment of the great fjords, such as that of Sognefjord, limits the penetration of rain and warmth-bearing winds. There are great differences in the local climate as is shown by Godske's study of the climate of the Bergen region.

In the fjord country agriculture, supplemented by the exploitation of the forests, is the mainstay. Arable land, which continued to be worked on the runrig system long after it was abandoned in eastern Norway,[1] is limited by the shadowed sides of the valleys; even in the most open valleys the difference between a north and a south aspect of a valley flank is significant, but it may be subordinated to factors such as soil quality, accessibility and relative frequency of avalanches. In many of the inner fjord and side valleys there are insufficient safe building sites and those used are a compromise between the dangers from flood, snow and rock avalanches and landslips. Damage may come from the blast of air generated by the avalanche or from a wave if the debris falls into a fjord. In the Olden valley the fear of avalanches is so great that almost all the houses are in the centre of the valley. Settlement on the fjord sides takes three main forms: it may climb an embayment of gentler slope, it may follow a raised beach or it may occur as isolated units on shelves high up on the fjord side or on the floors of side valleys which "hang" to the main valley. Each valley contains its farms, often situated on the terraced deltaic fans of side streams which are not liable to flooding from the main streams, and on the farmlands are cultivated a little oats, barley and mixed grain and the pastures are used for raising cattle, sheep, goats, pigs and horses. To increase the value of the pasture and to conserve most of the farm grass for hay the livestock are moved up to the sæters in the summer months. Besides producing grain for fodder and selling dairy produce the farming families practise domestic industries to supplement their income. In the inner fjord districts properties are small and even-sized because sub-division has gone far, owing to the scarcity of farmland, and there are few large farms with hired labour, but on the outer fjord districts holdings are larger.

The coastal strip is marked by characteristics which distinguish it from the rest of the Norwegian coast. Round Bergen are great arcs of schist and limestone rocks. Outlying islands of the skjærgård

[1] The relatively recent change from runrig in western Norway accounts for the high proportion of modern farm buildings which were required with a scatter away from a "township" clustering.

were formerly covered with pines but these have now vanished and the only trees are small thickets on the lee side of the larger islands. This disappearance, which may be due to goats or to burning, means that the people have to burn peat which is not easy to dry for fuel in this moist climate. The population are fishermen-farmers, for only south of Bergen does the amount of low land with a soil cover become sufficient for whole-time farming.

The resources of Vestland include mining and hydro-electricity and it is impossible to separate these between the fjord and west coast regions for they are so interconnected. Mineral wealth is

A.C.O.] [*September, 1953*

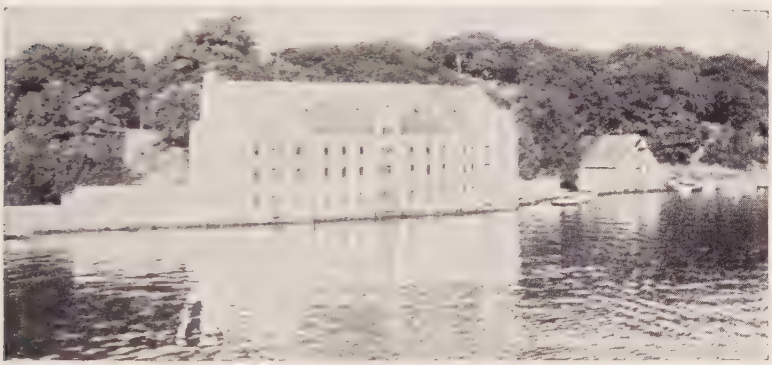
FIG. 97.—BERGEN.

This view is taken from the north-west looking into the old harbour round Vågen. The steep hill-flank on the left is approached by the Fløien funicular railway.

rare but on the islands of Karmoy and Stord pyrites is worked on a considerable scale while at Hosanger and Fano nickel is obtained. The comparatively high waterfalls and the heavy rainfall encourage the provision of hydro-electricity and round these centres industry has developed, but owing to its type the number of workers is not large. Some of the power stations are worked with a considerable head of water, e.g. that at Tysse has 1,350 ft. (411 m.) and Flörli 2,400 ft. (731 m.). The use of this power is illustrated by the Tysse station which supplies current for the electro-chemical works at Odda, the aluminium refinery at Tysse and the zinc refinery at Eitrheim. Some of the centres of electricity production have grown

rapidly, e.g. the town of Odda, in Hardanger, founded on the basis of an electro-chemical industry in 1926, had a population of about 8,000 in 1946.

Bergen stands out as the leading urban unit of Vestland. About two-fifths of the population of the region live in Bergen: this is partly because of the poverty of the hinterland. Founded between 1070 and 1075 under the name of Björgrin, the town only became well known to the outer world when it was selected as a trading centre by the Hanseatic merchants, relics of whose houses still stand. It was through a ship trading from England to Bergen in 1349 that the Black Death plague was brought to Scandinavia and killed one-third of the population. The town is located on a lowland formed of Cambro-Silurian schists and limestone at the foot of hills and old deltas up to



A.C.O.] [*August, 1953*

FIG. 98.—STAVANGER.

This is a typical industrial location alongside the deep-water approach to Stavanger.

200 ft. (60 m.) above sea-level. While there are excellent sea approaches and good shelter for ships Bergen is in a district of poor soils and limited resources, and connection with the non-coastal hinterland is inadequate owing to the grain of the country. Despite these disadvantages Bergen became the centre of the dried-fish trade of the Norwegian coast and also a grain importing port. From 1600 until about 1840, although repeatedly destroyed by fire, it was the largest city of Norway, indeed for some periods in Scandinavia, and although now displaced in that respect by Oslo it still remains a great commercial centre with a large home merchant fleet and industries, which started with the industrial revolution of the 1840s. These include shipbuilding, wool and cotton manufactures and flour-milling —the last a relic of the ancient grain trade of the city. As a result

of the centuries-old commercial activity many of the citizens are of foreign descent—Dutch, Swedish, German and Scottish. The town, originating on the peninsula of Nordnes, has been able to expand along the flanks of the adjoining fjords as well as inland along the lowland followed by the railway. If a tunnel were constructed eastwards towards Sørfjorden it would turn Arna, already a textile centre, into a suburb of Bergen.

Stavanger, at the southern limit of the great fjord country, acts as an intermediary between the sea and the fertile lands of Jæren. It is also well placed for North Sea commerce and is an old trading centre. Its great industry, begun in 1873, is the canning of sild and brisling, while there are several other activities such as engineering which sustain its people and maintain it as the fourth city of Norway. Midway between Stavanger and Bergen lies the active herring fishing town of Haugesund.

SØRLAND

South of 59° lies the district of Sörland, more narrowly defined as extending between Flekkefjord and Kragerø, a low plateau rising only some 330 to 1,000 ft. (100 to 300 m.) and with fjords and islands smaller than those of Vestland. It lies in a great semi-circle between Stavanger and Skien fjords and is formed of granite, gneiss and labradorite. With intense ice-scraping the rotted rock has been removed and the soil cover is limited except in some of the valleys and in the coastal fringe. The landscape is marked by a fan of rivers and lakes which radiate from the higher land of Byklfjell. The coast, almost to Flekkefjord, is exposed and lacks shelter and there can be but slight development of fisheries: this stretch of coast, lacking a channel protected by a skjærgård, is one of the most dangerous on the shores of Norway. It is in this stretch, however, that there occurs Jæren, a small area of some 187 sq. miles (500 sq. km.) which is formed of thick glacial deposits, partly derived from the Oslo area, reminiscent of those of Denmark, with a dune-fringed coast. On a shelf of solid rock moraines over 330 ft. (100 m.) thick have been deposited; during the last glaciation Jæren was completely covered by a piedmont glacier of little erosive power but in this period were formed low rounded eskers. Most of the surface was too high to receive a cover of marine clays during the marine transgression of immediate post-glacial times. In the historic past there were areas of poor drainage but much has now been reclaimed, and in recent years Jæren has had more land brought under cultivation than any other district of Norway, and it is now a centre of oats cultivation and, like Denmark, a producer of pork, butter and eggs.

On these plains, too, sheep are kept, with transhumance to the plateau in summer, for owing to the mild winters sheep can be kept without shelter. This activity is responsible for the woollen industry, one-quarter of the woollen textiles of Norway being manufactured here. Further south is the Lista peninsula which is a miniature Jæren both in physical features and human response. On the sandy terrain south-west of Stavanger was created in 1939

FIG. 99.—JÆREN.

This region has been described as being Danish in character and these two diagrams together show some of the physical characteristics compared with those of the highland more typical of Norway. In the right-hand diagram buildings, except in Stavanger, are shown by dots and the line running south from the town is the railway opened in 1878. See also Fig. 78.

Based on Jubilee Volume of *Norsk. Geog. Tidsk.*, 1939, p. 122; T. Sund and A. Sømme, *Norway in Maps*, 1947, Part B, p. 27 and local 1:100,000 maps.

the largest airport of Norway: this was greatly enlarged during the German occupation and Sola airport is now the terminus of a North Atlantic air route.

At Flekkefjord simple fjords reappear and there is a slight development of a skjærgård. All the valleys into the interior are short, except that of the Ottra, and end in cul-de-sacs which prevent contact with other districts. The Ottra river forms Setesdal which below Byglandsfjord opens into undulating country known as

Ottendalen. In this region the land has been raised only some 165 ft. (50 m.) and this accounts for the sparseness of settlement inland, for the interior is difficult of approach.

The falls on the Ottra river, as on the parallel streams to the west, have been harnessed for hydro-electricity power, although of course the head is low. The power is principally consumed in the aluminium works of Eydehavn and Vigeland, the electro-chemical plant of Kragerø and Salterød, and ferrosilicon manufacture at Fiskå. The exploitation of mineral deposits includes the working of titaniferous iron-ore at Sogndal in Dalene, molybdenite at Fjotland (Vest-Agder), titanium in Aust-Agder and manganese near Kristiansand. Using some ore obtained from near Bergen and Oslo, as well as imported Canadian matte, there is a nickel-copper refinery at Kristiansand. The convergence of Setesdal and Topsdal led to the growth of Kristiansand near the extreme south of Norway. This town is favoured as a port, for it lies near the busy maritime thoroughfare of the Skagerrak and fishing grounds producing mackerel, prawns, oysters and lobsters. These coastal lowlands also have an asset in their forest cover; the western limit of spruce in south Norway occurs near Kristiansand, and all the rivers, as far east as the Skien, are important for log-floating. With many creeks this coastal stretch was, in the nineteenth century a region of ship-building with Arendal as the chief centre. The turnover to the iron ship was a blow to the prosperity of the region (except at Farsund where, with a population of 1,600 there were in 1950 102,000 tons of shipping registered) but now it has acquired the industries of paper and pulp manufacture and, at Kristiansand, the largest plywood factory in Norway. The rise of these industries, aided also by timber import from the Glomma valley, has enabled the towns to maintain and even increase their populations, but the rural districts, particularly the moorlands, have been regions of depopulation. Aust-Agder province, which had only three per cent of the Norwegian population, supplied one in ten of the emigrants to North America during the great period of emigration. Along the coasts there are many outports but with the spread of rail and road transport facilities and the focusing of traffic on Kristiansand after 1920, these have degenerated from trading centres to fishing harbours and tourist centres. This southern coast has become the holiday coast for the Norwegians while Kristiansand is the approach to the famous Setesdal.

ØSTLAND

This region is taken as including the land sloping east from the fjell between Skien and the Swedish frontier; that is the region

which has most natural contacts and similarities with Sweden; indeed, it includes the headstreams of some Swedish rivers. It is an area of economic activity which contrasts with the rest of Norway. With only one large fjord, no strandflat and little development of the skjærgård it is a region very different physically from the rest of Norway. The rivers are long and have a great flow of water but usually have low falls, and the climate is more continental. In short, much of this region is identical with the adjoining parts of Sweden and the boundary is imposed by linguistic and historical and not by geographical factors. The rivers are liable to floods destructive of farm lands if the snows melt before the lower courses are clear of ice, but these floods are generally less devastating than those of the mass of the fjord area. With the transformation into a modern economy the region as a whole has become the premier area of Norway and has drawn to itself an ever-increasing proportion of the population.

Ostland, with semi-continental climate and fertile soils, has the most luxuriant vegetation of Norway, especially around Oslofjord. Coniferous forests of Scots pine and Norway spruce rise up to about 2,000 ft. (600 m.) with the former dominant on dry sandy areas. In the lower altitudes, on south-facing slopes below 1,600 ft. (490 m.) deciduous trees such as oak, ash, lime, maple and elm are mixed with the conifers. Above the conifer belt birchwoods extend to about 3,250 ft. (990 m.) and rising above that again are slopes covered with dwarf willows and lichens. The highest part of the mountain forest is known as *vernskog* (protective forest) because it protects the more valuable trees lower down from wind; it must not be carelessly cut for the tree growth is so slow that it is easy to lose this protective belt altogether.

While Østland all drains to Oslofjord it tends to be subdivided economically into the various river basins and these developed a regional consciousness particularly before the days of improved communications. Long isolated upstream of the lowland section, the upper valleys form such distinct units that they have acquired district names, for example, Numedal begins at Kongsberg, Gudbrandsdal at Mjøsen and Østerdalen at Elverum. These main valleys are characterised by the gentle rise inland of their floor, although there are breaks in the thalweg curve, owing to the effects of long continued erosion, and to the heavy glaciation which has been experienced. Many of the side valleys have a V-shaped cross-profile due either to protection from the flow of ice or to erosion during the post-glacial period. The existence of falls in the lower courses—there are for example seven large falls on the Glomma between Lake Øyeren and the sea—is due to geologically recent

uplift. As a result of ease of movement and of settlement these valleys have long contained the life of this forested land, which possesses at least three-quarters of the timber reserves of Norway. The Glomma can be used for floating timber—though many of its tributaries are useless for this purpose on account of waterfalls—so the forest wealth can be readily exploited. At first life was centred in great farms in the upper valleys but with the nineteenth century, and the cutting of timber for export, settlement spread more widely.

The warm summers of eastern Norway permitted agricultural settlement to be pushed much higher than in the British Isles or in western Norway but it has been realised that crop growing had extended above the reasonable prospect of obtaining a regular harvest, and the upper limit of cropping has been lowered some 500 ft. (150 m.) down the valley sides. The expansion of cropping was partly in response to the demand for foodstuffs for mining centres such as Røros or high forestry areas such as Sollien. In these open upper valleys aspect becomes important and most farms are located on the sunniest portion of the south-facing slopes. Even so, agriculture is too poor to support a considerable population and many of the cottars, now freeholders, acquire most of their living from forest work. In the eastern districts settlement is generally in larger units and is more continuous than in western Norway; it tends to be aligned along the main valleys and their principal tributaries, which are separated by residual ridges carved from a plateau surface; the settlement may be several farms deep as in the less confined stretches of agricultural Gudbrandsdal or it may be interrupted, as in the narrower stretches of forested Østerdal. Farms have tended to remain large and to be partly worked by labourers living on small crofts. In the lower plateau districts settlements coincide with the richer soils interspersed with sparse settlement and forested knolls but further upstream settlement becomes discontinuous and takes its main pattern from small-holdings created to exploit the lumber and not for the convenience of farm working. To-day these main valleys are threaded by roads and sometimes by railways. Hamar at the convergence of a cross-route from Østerdal with the Lågen valley, in a district of early settlement, was selected as the site of a bishopric in the eleventh century and still remains a regional capital. North of Lillehammer the main valley becomes narrow and at the strategic gorge near Kringen, in 1612, a body of Scottish mercenaries under George Sinclair was ambushed on its way to Sweden; over three centuries later Norwegians ambushed German forces at this point.

The valleys are eroded in Silurian rocks, largely calcareous, with fertile alluvial deposits which nourish rich pockets of agriculture

in the forested regions: such a pocket is that round Lake Mjøsa, the largest lake in Norway. Here calcareous Cambro-Silurian rocks and fertile moraines provide the basis for agriculture whereas immediately to the south thinly covered gneisses and granites bear only forest and settlement is confined to hamlets and isolated crofts on the patches of better soil. These farms have a considerable output of butter and cheese, for even here the climate is not ideal for crop growth and farms tend to be larger in order to compensate for the lower crop yields. The density of the agricultural population on the fertile patches is equivalent to that of Denmark but unfortunately the total area of such land is limited. Some of the clay-bottomed valleys, as in Lesja, were once ice-dammed lakes and therefore the clay has a sharp upper limit. In Lesja this limit is also that of settlement because the climate is so dry that only deep, moisture-retentive soils can be cultivated. Normally in Norway these wet clay soils have only been recently settled because the art of drainage was late acquired.

Between the plateau of Sørland and Vestfold[1] is a district formed of schists and calcareous Silurian rocks and drained by the Skie. This river system, of a dendritic pattern rare in Norway, is the natural outlet for the Telemark district which is a transition area between the vidder and the better country of the east. The mountains are composed of varied material from schists to ancient lavas and differential erosion has produced a picturesque accidented relief, which is beautified by many falls and lakes and by patches of coniferous and deciduous trees. Telemark is cut by three main rivers—the Toakvand, the Seljord and the Tinne—which flow into Norsjø; their combined waters to the sea are known as the Skie. The stretches of waterway between the lakes have been improved to make them fit for navigation by small craft. Telemark has considerable mineral resources round Tinnsjø; while copper is the main metal obtained there are minor quantities of gold and silver. The mine at Åmdal first started working in 1691 and has continued spasmodically ever since. In the lower Skie valley paper making is carried on at the head of sea navigation where water-power is also developed from the falls. The main town on the fjord is Porsgrunn and this is a pottery centre.

Vestfold to the north-east of the Skie estuary consists of igneous rocks with an extensive fluvio-glacial cover of *ra* and post-glacial deposits up to 490 ft. (160 m.) above sea-level. Deep water inshore has favoured the construction of port facilities while the thick soils and the open country with a warm summer climate favour agriculture.

[1] Oslofjord was formerly called Fold, hence the terms Østfold (East) and Vestfold (West).

It is a region of wheat cultivation, of fruit orchards and market gardens and pastures used for producing butter and cheese. The woodland is mainly oak. This district is one that had a dense population from pre-historic times until the Viking period—the Gokstad war vessel and Oseberg Queen's ship were found here—but it only began to prosper again in modern times when the ports engaged in whaling and industries such as ship repairing and the treatment of whale oil arose. In the district between Tönsberg and Larvik labradorite, an opalescent monumental stone, is quarried. The chief industry is aluminium refining at Holmestrand.

To the north of Vestfold lies the open fertile valley of the Dramselv which has many low forested hills. The district has acquired its modern value from the presence of the great falls on the edge of the fjell country. Power stations using these high heads of water—Rjukan has falls of 815 and 920 ft. (248 and 281 m.) on the Måne river—support the chemical industries of Rjukan: hydrogen, oxygen, heavy water and nitrate fertilisers. This district also contains the Kongsberg silver mines which have been worked by the King or State since 1623, with a short break in production early in the nineteenth century, producing between 1624 and 1938 2·8 million lb. (1·26 million kg.) of silver. As late as 1769, about the period of maximum activity, Kongsberg was the second largest town in Norway, having a larger population than Oslo and Trondheim; in 1769 Bergen had 13,735 persons, Kongsberg 8,068, Oslo 7,496 and Trondheim 7,478. In 1957 the Kongsberg silver mines were closed. The only other mineral which has been of any significance is cobalt, which was mined in the last century. Drammen, fifth town of Norway, was originally just a centre for the sale of logs and sawn timber, for the Dramselv is the second greatest timber-floating river in Norway; it now makes chemical and mechanical pulp and paper and its mills are the most important in the country. At Slemmestad, on the shores of Oslofjord, is the largest cement factory in the country dependent on an outcrop of Cambro-Silurian limestone.

On the eastern side of Oslofjord is the district of Østfold and Akershus which extends south from Kongsvinger and Mjøsen lake to the Swedish frontier and has the character of the adjoining Swedish plateau with a height only exceptionally reaching 1,640 ft. (500 m.). Crossing this region is the Glomma and its great tributary the Vorma and the valleys of these rivers differ from most Norwegian valleys in that they are broad and open. This region is the only one in Norway where fortifications were built on a large scale in modern times, apart from the period of German invasion, and this was due to the lack of a natural line of cleavage between the two countries. It is an area where the land has risen appreciably in post glacial times

(a fjord once extended inland to Mjøsen, the surface of which is now 407 ft. (124 m.) above sea-level although the bed of the lake descends to 1,076 ft. (328 m.) below sea-level), and the sandy marine alluvium gives a fertile agricultural soil; over one-fifth of the land is cultivated, a considerable proportion for Norway. To the south-east is a marginal ridge formed of morainic deposits, known as *Ræt*. Opening southwards from Moss and Horten on Oslofjord and outside Ræt, is the former sea-bottom but on the north side, where the ice retreated rapidly, the superficial deposits are thin. The sandy soils of Ræt, naturally well-drained, provide a more suitable location

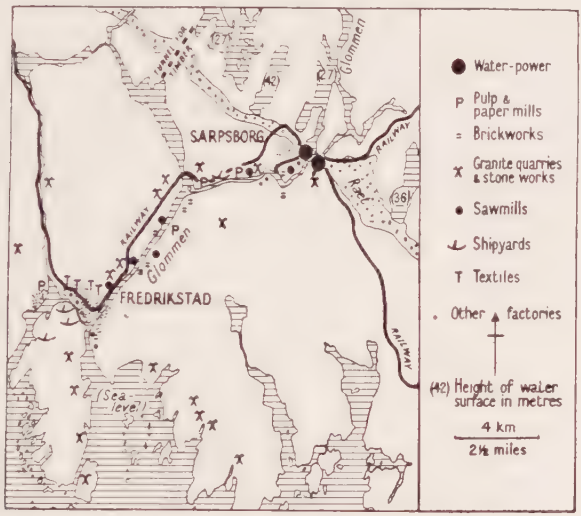


FIG. 100.—INDUSTRIAL DISTRICT OF SARPSBORG-FREDRIKSTAD.

With a variety of industries and local water-power this is one of the most valuable industrial districts of Norway.

Based, with permission, on T. Sund and A. Sømme, *op. cit.*, Part B, Fig. 5 and H. W:son Ahlmann, *Norge*, Stockholm, 1943, Fig. 58 and Topog. Kart. Norge Sheet 10c.

for settlement and routes than the adjoining clay areas; there is, however, no railway as, although straight, Ræt does not connect large, modern settlements. The morainic cover is often pock-marked by numerous kettle-holes with lakes while locally sand dunes exist as a result of strong, out-blowing winds when the ice still remained to the north. Fine sand was blown into the fjords where it covered marine clays and such deposits are termed *mjæle*. Later occupied than the clays the mjæle plains can, with drainage of the peat cover and with the use of fertilisers, be rendered fertile and thus have become districts of recent agricultural settlement, absorbing an

increasing rural population. The clay areas of the Østfold can be distinguished by their cover of spruce and the sandy tracts by pine.

The climate becomes more continental towards the north-east and is favourable for wheat, oats, rye and potatoes; fruit production and the dairy industry are also valuable because of the proximity to Oslo. Only in the outer districts such as Hedmark is the milk made into condensed milk, butter and cheese. The large potato crop of Hedmark is mainly used for distilling and for the production of potato flour.

In the extreme south lies the industrial district which contains one-third of the population of Østfold. It stretches for eighteen miles (29 km.) along the Glomma between the towns of Fredrikstad and Sarpsborg. Hydro-electricity from Sarpsfoss rapid is used for timber-working, iron alloys and carbide production at Sarpsborg and phosphorus at Fredrikstad. The Glomma is the largest timber-floating river in Norway and at Sarpsborg is located the biggest timber manufacturing firm in Norway. Sarpsfoss owes its origin to a diversion of the river which followed a filling of the pre-glacial channel by the Ra moraine. The Glomma is navigable nearly to Sarpsborg for ships of 10,000 tons d.w. and this is an asset to the industrialisation. Halden is another industrial centre and here are made caustic soda, cotton textiles and matches. The granite outcrops provide the basis of a granite industry and the Iddefjord quarries produce a well-jointed fine-grained grey granite, similar to those of Bohuslän, which is finer than the reddish granites of Drammen. The working of these granites is aided by the fine joints which run at right angles and facilitate the production of setts and building stone, but they encourage exfoliation and reduce the wearing capacity of the setts and kerbstones.

Oslo region

The region of Oslo is mainly formed of Cambro-Silurian rocks, which were folded, faulted, metamorphosed and injected with igneous rocks during the Hercynian orogenesis. Caps of Permian lavas and plutonic rocks, which have repelled settlement because they have a cover of forest, peat bog and small lakes, form the horizon round the capital, which lies in a basin of Pre-Cambrian and Cambro-Silurian schists. These wooded fringes have provided valuable recreation grounds for Oslo citizens. The Oslo region was crossed by the ice sheet moving southwards, but fortunately a large marginal terrace was left during the retreat and the shell-rich marine deposits give rise to fertile soils, limited towards the interior by the Ra moraine. During the post-glacial period there has been considerable uplift and

the marine deposits exposed on a shelving land edge have fostered settlement and agriculture. The shallowness of the coastal waters of Oslofjord is seen by the relatively wide expanse of foreshore exposed

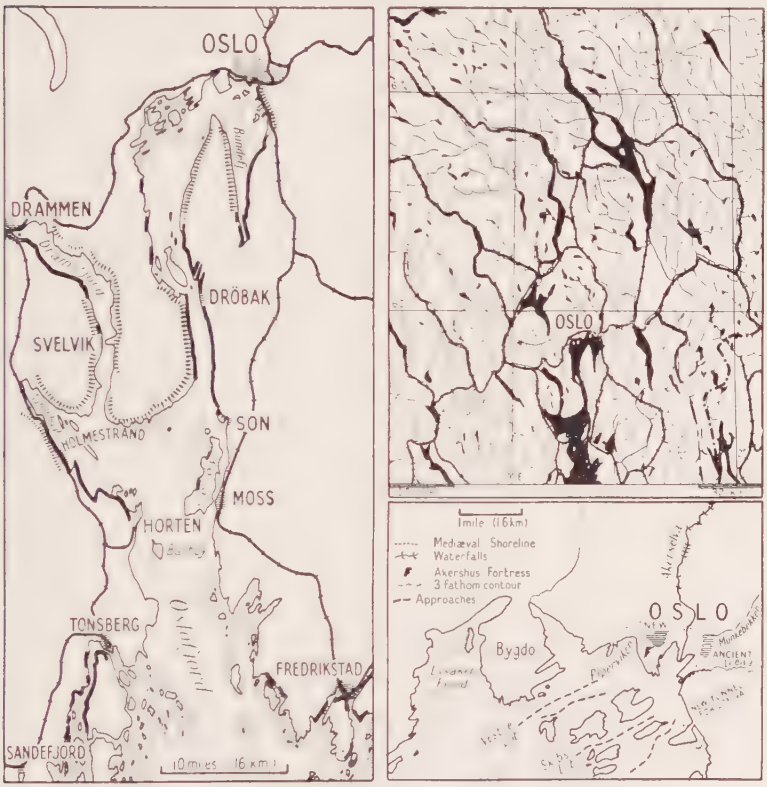


FIG. 101.—OSLO.

In the left-hand diagram "foul" areas in the fjord are indicated by stippling, low cliffs by a heavy line and higher cliffs by hachures. The site of Oslo with its ancient and modern locations and proximity to falls on the Akerselv, providing water-power, as well as the former shoreline are shown in the bottom right-hand diagram. In the top right-hand diagram water areas are shown in black and the 400 m. (1,300 ft.) contour is lightly dotted; railways are also shown.

Based, by permission on T. Sund and A. Sømme, *op. cit.*, Part B, p. 16 and the 1:1 million map of Europe and German charts of the Norwegian coast.

at low water although the tidal range is only a few inches, and if the uplift continues, there may well be an extension of the tillable area.

Oslo[1] is the focus of Østland and lies at the head of a 62 miles (100 km.) long navigation from the open sea where there is a small

[1] Called Kristiania, 1618–1925.

Land Uplift in the Oslo District

Period	*Type of Axe*	*Approximate dates,* B.C.	*Rate of fall of sea-level per century*
			m.
Norway's Youngest Stone Age (Copper Age) Younger Tapes Time; Sub-Atlantic climate	Thick-necked axe, also perforated (shaft hole) axe	2,400–1,900	1·8
Norway's Younger Stone Age: Younger part (Middle Tapes Time; sub-boreal climate)	Thin necked axe	3,400–2,400	2·1
Older part	Pointed necked axe	3,900–3,400	2·2
Norway's Middle Stone Age (Old Tapes Time with Atlantic climate) . . .	Blunt necked round axe; also pointed necked axe.	4,900–3,900	1·2

(Based on W. C. Brøgger, quoted by Dewey, p. 159.)

depression created by a narrow fold of the Silurian schists between the low rounded hills of igneous material. Although it was founded in the eleventh century round Akershus fortress and is on a seaway into which six "floatable" rivers converge, Oslo remained until about a century ago subordinate to Bergen in size and trade. The original site was deserted in 1624 after a fire and it was moved to a higher site on rock. The town grew slowly until the coming of the railway in 1854 allowed it to realise its nodal position in Østland. The steep fault-line scarps made it difficult to construct railways and modern roads and there are either steep grades or frequent bends to conquer the altitudinal differences. People have settled along the railways and roads in a suburban pattern while the islands have summer residences similar to those scattered round Stockholm. In the Oslo district live a quarter of the industrial workers of Norway and along the valley of the Akerselv, using water power, the industrial revolution of Norway commenced about 1850. The largest industry is concerned with metals and every third worker in Oslo is now engaged in it. Until the mid-nineteenth century, when the lower Glomma was opened for timber floating, Oslo, with a natural harbour, exported local timber, particularly to England, but now over its quays pass imports of grain, colonial produce and manufactures. The port handles nearly one-half of the imports of Norway but only sends abroad about one-seventh of the exports: and its proportion of Norwegian exports is declining as the other industrial centres develop. The principal item of export is still timber and its products—pulp, paper, cardboard and cellulose.

Though of old foundation, this capital city has only recently grown rapidly: in the last half of the nineteenth century from 31,715 in 1855 to over a quarter of a million and in the first half of this century to nearly half a million. Oslo is the "nerve centre" of Norway, partly because it is the financial centre and partly because it is the principal transport node. When Aker was merged into the Oslo city administration this increased the population by some 135,000 persons but most of them, though not residents, already worked in the capital.[1] The great size of the city has raised local transport problems: the Holmenkollen railway opened in 1898, was extended in 1928 as an underground line to the centre of the city, the first such line in a northern capital. Plans exist to extend this underground line and to improve the passenger facilities by a new central station. The same fears have been expressed in Norway as in Denmark or England, about the drift of people to the capital. This migration to Oslo is of great significance, for three out of every five residents have been born in the provinces. The "immigration" has been helped by the active area associations of which, naturally, the oldest was that for people from the remote Nordland.

[1] From 1st January, 1948, the municipality of Aker was incorporated within the city with the result Oslo is now one of the largest cities, by area, in the world.

CHAPTER 11

NORWAY'S ARCTIC ISLANDS

To the north of 70° N. and reaching into the zone of seasonal closure of sea navigation by ice are situated certain islands which are believed to have been discovered by the Norse and re-discovered by the Dutch, but which for centuries were *terra nullius*, until in the 1920s they came under the Norwegian flag. In this century Norway has displayed most interest in Spitsbergen, Bjørnøya (Bear Island) and Jan Mayen, the first for hunting and coal supply and all three for scientific purposes. This is, indeed, not unexpected, as the islands are more readily approachable from Finmark and from Harstad and Tromsø than from any other part of Europe. Isolated as they are, they nevertheless form a zone of political contact, and of potential friction, between the Norwegians and citizens of the Soviet Union, for Spitsbergen was long of interest to Russian hunters and the coal is mined by Russians as well as by Norwegians.

The discovery of Spitsbergen and Bjørnøya, after the Dark Ages, came as a result of the quest for the North-East Passage to the Far East. It is possible that they had been known previously to illiterate hunters from the Murman coast, but this knowledge was inaccessible to the main stream of European scholarship. In 1596 Willem Barents, a pilot, gave Spitsbergen its name because of its peaked mountains, but no real interest was displayed until Henry Hudson reported in 1607 on the great number of whales and seals; then for many decades whalers from the Netherlands, Britain, Denmark and the Basque coast caught whales and squabbled in these waters from Jan Mayen to Spitsbergen. When they had robbed the waters of their mammals, hunters took a heavy toll of the land mammals and the islands almost ceased to have a commercial value until the working of coal in this century. In 1920 Norway was granted sovereignty of all land between 74° and 81° N. latitude and 10° and 35° E. longitude: this area was named Svalbard. The Norwegians established meteorological stations[1] and these, with the coal workings, were the reason why these remote islands were caught in the turmoil of war. In August, 1941, British forces took over Spitsbergen; the 2,000 Russians living there were shipped to Archangelsk and the Norwegians to Britain and the coal store was burnt.

[1] The station at Green Harbour, Spitsbergen, was established in 1911 and the one on Bjørnøya in 1917.

The Germans established a base which was captured by Norwegian forces in 1942, but in 1944 the German warships *Tirpitz* and *Scharnhorst* with a destroyer force laid waste practically all the settlements. Air-attacks only were made on the meteorological station on Jan Mayen. This campaigning, like the previous occupation, had been made in an environment which for centuries had been regarded as impossible for normal activities and where settlers were liable, under the arduous conditions, to suffer from polar melancholia.

SPITSBERGEN

76° 28′–80° 42′ N.
10° 32′–33° 31′ E.

Svalbard, the *Cold Coast*, is recorded in a saga as having been discovered in 1194 but no use was made of the discovery and the land, if the saga is correctly understood as meaning this archipelago, was forgotten for four hundred years. This is not surprising, for to classical scholars the north was a frozen, unfriendly waste and the distances were so great as to make voyages from the ports of the North Sea area unduly long. The approximate distances from Isfjord in Spitsbergen to various ports are:

	Nautical miles	*km.*
Aberdeen	1,300	2,405
London	1,750	3,237
Bergen	1,150	2,080
Tromsø	520	962
Pechenga	640	1,084
Murmansk	650	1,103

In 1596 Barents claimed the land for the Dutch, in 1613 Fotherby and Baffin for Britain, while in 1618 the Danes revived their claim to Lordship of the Northern Seas.[1] There was for long considerable confusion as to what lay in the area and it was sometimes believed to be part of Greenland; some eighteenth-century maps so name it although they may differentiate by calling it East Greenland. Sovereignty was claimed after the value of the whale fisheries had been established, but the land was not explored or regarded as having a value other than as a base for whale-catching and rendering down the blubber.

For some time about 1720, Russians from round the White Sea trapped fur animals while living in the archipelago, which they called Grumant, during the winter; before this the first successful

[1] The mediæval Norwegian claim to sovereignty was the basis of this later claim by the double monarchy of the Dano-Norwegian crown.

wintering had been by eight Englishmen accidentally marooned in 1630–1. Before the close of the eighteenth century Norwegian trappers were supplanting the Russians and sending the produce from white whales, walruses, seals and sharks, the skins of polar bears and foxes, and down from eider ducks to Hammerfest and Tromsø, thus establishing the linkage between Spitsbergen and those ports. By the Treaty of Paris, 1920, Svalbard was placed under Norwegian control but the Norwegian flag was not hoisted at Longyearbyen until 1925 as there were delays in ratification.

Knowledge of the archipelago had increased partly as a result of private investigations, such as those of William Scoresby (Junior), and partly by organised work, first by the Swedes, particularly Nordenskiöld, and then from 1906 by Norwegians whose interest in the area resulted in the foundation in 1948 of the *Norsk Polarinstitutt*, (from 1928 *Norges Svalbard- og Ishavs- undersøkelser*), of Oslo. Since the realisation early last century there was no passage to the North Pole in this sector the British Government did not sponsor work in the Svalbard district. As a measure of the increase of knowledge the archipelago was circumnavigated for the first time as recently as 1863, although by now it has been completely photographed from the air for survey purposes.

Spitsbergen is about the same size as Scotland, having an area of 24,095 sq. miles (62,406 sq. km.); it is thus about one-fifth of the area of the mainland of Norway. The largest island, Vest-Spitsbergen, has an area of 15,250 sq. miles (39,500 sq. km.) and the second largest, Nordaustland (North East Land, once known as Smyth's Land), 5,800 sq. miles (15,000 sq. km.). The island of Hopen consists of a long, narrow ridge with flat-topped mountains formed by horizontal rocks and, despite the absence of harbours, a meteorological station is maintained, with mails dropped from the air. The archipelago stretches for 270 miles (450 km.) from north to south and for 248 miles (400 km.) from east to west. The relief in the glacially dissected upland appears mountainous and the highest mountain is Newtontopp, 5,630 ft. (1,717 m.). Broad valleys cross the mountains and with the permanently frozen subsoil drainage is unusual, rivers tending to be shallow and braiding on the surface. Large fjords facilitate access into the area: Isfjorden, 55 miles (88 km.) long, is more important than the longest inlet, Wijdefjorden (65 miles or 104 km.), as it cuts through the main coal-bearing area.

A considerable proportion of the surface (about one-quarter) is covered with ice, with the lower line of the snowfield at about 1,300 ft. (400 m.) but there is no great central inland snowfield as in Greenland. While the glaciers still move slowly towards the lowland the fronts are retreating: between 1861 and 1937 one glacier front

into Kongsfjorden retreated 1,970 ft. (600 m.), while at Hornsund detailed maps of 1872 show that since then the ice front has retreated about 6 miles (10 km.) and about 12 sq. miles (31 sq. km.) has been freed of ice-cover.[1] The present glaciers are therefore, in general, the shrunken remains of a formerly complete ice cover, but later frost-action is obliterating the evidence of this. Partly because of the dwindling of the glaciers and partly because the glaciers entering the sea do not reach deep water, there is not, except on the south coast of Nordaustland, the same calving of giant icebergs as occurs off the coast of Greenland. The most north-easterly island, Kvitøya, where the remains of the Andrée Expedition were found in 1930, is completely covered by ice while Nordaustland is also dominated by its ice sheets which in places are about 2,300 ft. (700 m.) thick. Off Edgeoya Kong Johans Bre terminates in an ice-cliff up to 100 ft. (30 m.) high, and in front of it is a submarine bank extending out to sea for twenty miles (32 km.) which may represent moraine. The greater extent of the ice-cover in the east of the archipelago is probably due to the colder air accompanying the Arctic current which flows south along the eastern shore. With the ice brought from the north by this current to reinforce that formed locally, the period of open sea is much shorter and navigation is much more dangerous in the east than in the west.

Climate

Spitsbergen is only 595 nautical miles (1,100 km.) from the North Pole and it is the most northerly part of the world inhabited by Europeans, a distinction partly due to a climate more favourable than the mean for the latitude, with summers which are comparatively warm.[2] At Grønfjord the mean annual temperature is 19°F. (−7°C.) whereas the three months June to August average 39°F. (4 C.). This warmth results from the northerly extension of the North Atlantic Drift and allows sea access in the summer. The actual temperatures experienced at a site vary greatly according to aspect. As was noticed on the Buchan Expedition in 1818,[3] the wide inlet of Magdalenefjord has precipitous bounding mountains rising to some 3,000 ft. (914 m.) with an east–west alignment and the north facing flanks only get sunshine for a few hours at the height of summer, so they are covered in ice and snow; by contrast the northern

[1] See A. Heintz, Noen iakttagelser over isbreenes tilbakegang i Hornsund, V. Spitsbergen, *Norsk Geologisk Tidsskrift*, xxxi, 1953, pp. 7–36.

[2] The Greenland airbase established by the Americans at Thule (76 N.) is a more artificial settlement in that it has no economic basis.

[3] F. W. Beechley, "A voyage of discovery towards the North Pole . . . under the command of Captain David Buchan, R.N.; 1818," *Lond.*, 1843, p. 48.

shore is flushed with sun and bears a vegetation cover. The summer warmth was commented on by Martens when he noticed that in July, 1671, the tar on the whaling ship melted in the heat of the sun. The winters are severe and the sun is absent for about 116 days; at Longyearbyen the sun is not seen above the local horizon from 25th October until 18th February. Gales are frequent but fog is not so common in winter as in summer when the month of July averages four days of fog. Fog is more frequent on the outer west coast than inland. The mists come down very quickly and this may be due to the cold, dry polar air moving across the relatively warm ocean water. The climate was getting warmer during the first quarter of this century, possibly because the west coast sea temperatures rose

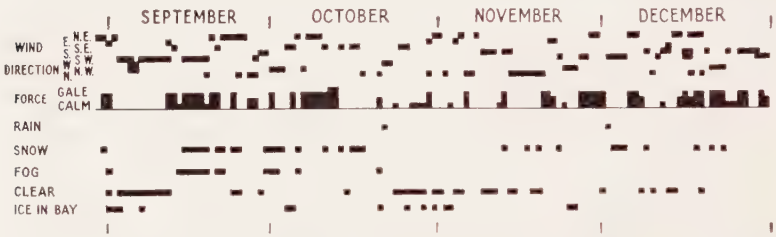


FIG. 102.—SPITSBERGEN WEATHER RECORD OF 1633.

This record was kept by seven Dutch sailors, commanded by Jacob Segersz van der Brugge, who wintered at Mauritius Bay in Spitsbergen 1633–4. Their report of the frequency of fog, snow and strong winds for long coloured European views on the winter climate.

Based on (Edit.) Sir W. M. Conway, *Early Dutch and English voyages to Spitsbergen*, Hakluyt Society, London, 1904.

5·4°F. (3°C.) from 1902 to 1922. In winter all the fjords freeze and the clearance of the ice which allows shipping to enter may be impeded by on-shore winds. The west coast fjords are usually free of ice, except for brash and pack ice, from June to September. Pack-ice from the east of Spitsbergen drifts round South Cape and can impede navigation as far north as Isfjorden. The fear of winter was first faced deliberately by a party of seven Dutchmen who were left to guard the stores in 1633–4, and the record they kept of the weather has an historic interest (Fig. 102) for, along with Pelham's account of an involuntary wintering by eight Englishmen in 1630–1, it conditioned the European outlook on the climate of the archipelago until Scoresby published his observations nearly two centuries later.

Geology and Soils

Geologically Spitsbergen is complex, the Cambro-Silurian rocks of the Hecla Hoek system forming the framework on which Devonian

shales and sandstone rest unconformably. These were overlain, after intervening uplift and denudation, by rocks from Carboniferous to Tertiary in age which, in the centre and east of Vest-Spitsbergen, were lifted almost horizontally with great faults along which the valleys and fjords have frequently been eroded. The older Palæozoic rocks of the north-west and the north-east which have been much

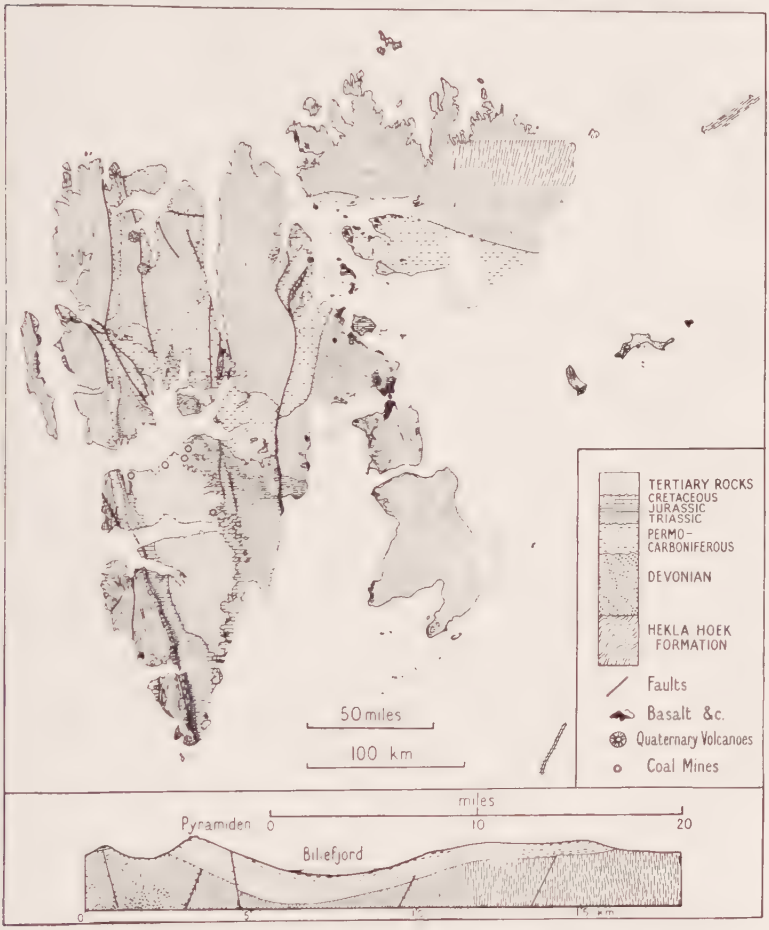


FIG. 103.—GEOLOGY OF SPITSBERGEN.

The solid geology of the archipelago is framed on the Hekla Hoek formation. Structurally there are folds with a north-south axis and more or less parallel faults. Sections of the coastline are in process of being mapped geologically from the air but in the east glaciers conceal the coast and the geology.

Based, by permission, on A. K. Orvin, *Outline of the geological history of Spitsbergen*, 1940 (Result. Norske stats. Spits., Nr. 78).

subjected to orogenic forces, present sharp peaks and jagged arêtes, whereas the newer rocks in gentle synclinal folds form a dissected plateau with flat-topped mountains. In the Ice Age there was a great ice-sheet over the whole archipelago and, although the features of glaciation are rapidly becoming broken down or scree-covered by frost-action, the scenery is typical of that resulting from heavy glaciation. The most recent volcanic activity has been in the north and at Bockfjord warm springs with sinter basins are the last signs of activity. Since the Ice Age the land has been uplifted, and there are many signs of the occurrence of this movement in recent centuries. On the northerly group of Sjuøyane whale skeletons occur on a beach high above the present sea-level—though skeletons which may have been hauled-up by Dutch whalers are not very satisfactory evidence. On a marine terrace at 130 ft. (40 m.) on Kong Karls Land ancient driftwood occurs *in situ*. Uplift has been greatest in the east of the archipelago and a beach in this group is 715 ft. (218 m.) above the present sea-level. These old marine beaches provide a ribbon of lowland at the foot of the mountains. In Prins Karls Forland (Prince Charles Foreland), for example, encircling the island, there is a broad coastal platform with an abrupt cliff foot at 150 ft. (45 m.); the platform bears three or more raised beaches.

Soils cannot develop freely in this ice-bound territory where there is a frozen zone (*tjäle*) as much as 900 ft. (275 m.) deep and only the top one to three feet (30–90 cm.) thaw in the short summer. The ground is not frozen under the sea or under big glaciers or lakes. Frost action develops ridges and polygonal arrangement of the stones in this zone of thaw, the *structurboden* of German writers. During Parry's attempt to reach the North Pole a soil sample was obtained at Hecla Cove (Sorgfjorden), described as covered with a tolerably abundant vegetation, and an analysis gave a humus content of 4 per cent, silica 70 per cent, calcium carbonate 8·5 per cent and iron carbonate 3 per cent.[1] Under the severe climatic conditions, the soil, leached by melt water, cannot mature and this further inhibits plant growth.

Flora and Fauna

Except for dwarf-birch and polar willow there are no types of trees growing in Spitsbergen and the highest growing plant is only 8 in. (20 cm.). There are no annual plants as they cannot mature in the short summers. Despite the poor vegetation cover there are reindeer (*Rangifer spitzbergensis*), of a species smaller than that of northern

[1] W. E. Parry: Narrative of an attempt to reach the North Pole: *London.* 1828. Appdx. by Robert Jameson, p. 225.

Europe, which feed off lichens and other plants. They are believed to have migrated across the ice to Spitsbergen and their presence has been fortunate for winterers and whalers who have shot them for food. In 1929 seventeen calves of musk-ox (*Ovibos moschatus*) were imported from Greenland and now they are found in herds of up to 30 head: they were protected in order to build up the herds, but this was interrupted during the war. Two carnivores of importance to hunters are polar bear (*Thalarctos maritimus*), normally found to the north but coming south in autumn after seals, and the arctic fox (*Alopex lagopus*), blue and white, which is trapped in the late winter when the pelt is in the best condition. In addition to the land animals there are those of the plankton-rich seas. The wild-life provided the first inducement for Europeans to frequent the archipelago.

Exploitation : Hunting

Spitsbergen used to be visited from 1715 until the middle of the nineteenth century by Russians who stayed in the archipelago for a year or two in groups of fifteen to twenty men. By the end of the eighteenth century, Norwegians arrived to hunt in groups of two or three men, but now each man has his own hunting area. The hunters had an arduous and lonely life in the winter, living in primitive huts made of driftwood.[1] They usually had a headquarters hutment and a hut at each secondary station. About 200 to 300 bears are caught annually in Spitsbergen, while seals are captured for the hides and the blubber. Unfortunately for a period the catch of bears and foxes was spoilt by the use of strychnine-poisoned bait, a practice forbidden by the Norwegian government in 1909. Until 1924 it was an uncontrolled hunting area but then hunting was forbidden for a decade; this prohibition has now been once more relaxed and certain animals can be taken, but not reindeer or musk-ox. In the season 1937–8 thirty-six hunters wintered in Spitsbergen.

Exploitation : Whaling

Of greater importance was whaling, and the phases of exploitation, with their speed, are fascinating when viewed against the background of the pre-industrial economy of Europe. In 1610 the Muscovy Company, acting on the report of Henry Hudson, sent out a ship to catch walruses at Krossfjord (Cross Bay). In the following year the Company sent out an expedition with expert Basque whalers and set

[1] Timber from Siberia, bearing evidence of having been frozen in ice, drifts up on the shore. An accumulation was especially great at Woodfjord, cf. Vedvik, Færoes, p. 309.

up rendering coppers at Engelskbukta (English Bay) but the expedition failed and had to be rescued by Thomas Marmaduke, an interloper from Hull. In 1612 another English expedition with two larger ships, a Dutch ship and one from San Sebastian were whaling in these waters. The Basque vessel obtained a full catch and in 1613 there was an influx of vessels and the number and country of origin of the whaling vessels shows the organising capacity of Western Europe at that period.

Whaling in Spitsbergen waters, 1613

Country	*Number of Ships*	*Notes*
English	7	By Muscovy Company, had 24 expert Basque whalers.
,,	2	Interlopers.
Dutch	2	Amsterdam, had 12 expert Basque whalers.
,,	2	Saardam, for walrus.
,,	1	Enkhuizer.
,,	2	Hired by Dunkerque merchants.
Basque	3	St. Jean de Luz.
,,	8	San Sebastian.
French	2	La Rochelle, one ship hired from Hoorn.

Later, whalers from Denmark and Hamburg also participated. Squabbles arose between the Dutch and the English, who sent armed vessels to protect their "rights".

The Dutch founded Smeerenburg (Blubber Town) in 1617 to render the train oil from the blubber.[1] The principal whale species caught was the Right Whale (*Balæna mysticetus*), which yielded whale-bone as well as oil. The French extracted the train oil on board their ships, which were very inflammable in consequence; the Hamburghers carried the fermented blubber in casks to Hamburg for rendering and the English adopted the Dutch system, with their base farther south at Engelskbukta. In spring the whales were found to the west, moving east towards Vest-Spitsbergen during the summer. The train oil was used for lamps and by carriers, clothworkers and soap-boilers. Bear fat was also rendered to give a thin oil like train oil and sold as such. Whalebone, the structure which filters the food intake of the whale, can be bent when warmed and retains its shape when cool; in addition to its use in corsets the material was adopted

[1] The number of men employed must have been, in the aggregate, very considerable, for Beechey records that on the Buchan Expedition in 1818 over a thousand coffins were counted on the low lands round Smeerenburg. Beechey, *op. cit.*, p. 160.

for brushes, umbrella ribs and ramrods. The average Greenland Right whale yielded about 15 tons (153 quintals) of oil and 15 cwts. (762 kg.) of whalebone.

The catch was enormous; Scoresby, towards the end of this phase, records the yields of the seventeenth century, when it is clear that the Dutch had become the leaders in the industry, and it is estimated that they caught 60,000 whales using Spitsbergen as a base. When the whales were caught in the bays almost any vessel, no matter how old or rotten, was of use but when, later on, whaling was undertaken near the ice-front and the sailing-date was advanced, craft had to be completely seaworthy. At the same time the catch was smaller and, to save time, vessels did not proceed to the rendering stations on the shores of Spitsbergen or Jan Mayen but carried the blubber to the home port at the end of the season. As the catch became less so bounties and remission of certain duties were granted by the various governments for, apart from the returns from the produce, the industry was valued as a nursery for seamen. Many of the British ships completed their commissioning at Stromness in the Orkneys or at Lerwick in the Shetland Islands.

Gradually the islands became neglected by whalers and sealers as over-catching of the Right whale took place, but when in the last century Svend Foyn invented the explosive harpoon a renewal of whaling activity was possible because other, larger species such as the Blue whale could be profitably caught. In 1904 the Norwegian Government, acting on complaints from the cod-fishers who believed that whaling damaged their industry, prohibited whaling stations on Norwegian shores. As a result stations were established on other northern shores such as those of the Shetland Islands, Færoes, Bjørnøya and Spitsbergen. Eight companies moved to Svalbard waters and whaling was prosecuted there, with a catch which varied from 599 whales in 1905 to 55 in 1912. Seven of the companies had factory-ships and one a shore station at Ankerhamna, Grønfjorden, which was used from 1905 until 1912. With the decline of the catch, whaling was again abandoned after 1912 and was only re-established, for the catching of small whales, in 1946. Whitefish, a whale about 18 ft. (5 m.) long, once very abundant in these waters, was caught and provided skin for leather as well as blubber and meat.

The shore-station for whaling at Ankerhamna also caught an insignificant quantity of salmon, but a more important fishery was that of cod and halibut. In the 1870's large shoals of cod were discovered, and in some years they are caught in abundance off the west coast and sent to Norway for salting or drying and the extraction of liver oil. The Greenland shark (*Somniosus*), about 23 ft. (7 m.) long, is caught by line for the sake of its oil-rich liver.

Exploitation : Minerals

Minerals have also been a magnet drawing Europeans to Svalbard. In 1917 a Norwegian company exported 160 tons of phosphates from near Kap Thordsen; a Swedish company had first worked a Triassic coprolite bed occurring on this low, comparatively fertile plateau alongside Nordfjord as far back as 1882, but the phosphate content was then found to be too low for economic working. At Skansen gypsum was mined but work was suspended in 1939: the beds aggregate 200 ft. (60 m.) in thickness and are suitable for the manufacture of plaster of Paris. As the only other European centres of supply are in the Paris Basin, Germany and the English Midlands these deposits may acquire considerable significance. Marble was quarried in 1912–13 on Blomstrand peninsula, near London beside Kongsfjorden, but it was found that the stone was damaged by frost. High hopes were entertained of the value of the iron ores: a magnetite ore, containing about 66 per cent iron, is found alongside Recherchefjord, where preliminary exploitation commenced in 1920, and in Prins Karls Forland (Prince Charles Foreland), and it is in sufficient quantity to deflect the compass of ships more than 4°. In the older rocks low grade ores, containing up to 20 per cent iron, are found but require concentration before exploitation is feasible. Among other minerals found is asbestos but though of good quality the quantities are considered too small to justify mining operations.

Scoresby recorded in 1820 that the Dutch whalers laid in a stock of coal for fuel on the passage home.[1] About 1830 a cargo of coal was carried to Finmark but another seventy years passed before there was another shipment to Norway. The quality of the coal is regarded as good and the reserves are great (see p. 470) but working was not appreciable until this century was well advanced. Part of the delay resulted from the difficulty, prior to 1925, of establishing mineral claims and in this period there was much rivalry between British, Norwegian, Russian, Swedish and Dutch interests. With the passing of the archipelago under Norwegian control claims were classified and the interests concerned reduced:

Nationalities of Concessions

Proprietors	1927	1938–51
Norwegian . .	14	32
British . . .	20	4
Russian . .	2	4
Swedish . .	2	0
Dutch . . .	2	0

[1] Jonas Poole reported in 1610 the occurrence of coal at Kongsfjord and Bjørnøya.

In 1939 the only two companies operating in Svalbard were the Norwegian *Store Norske Spitsbergen Kulkompani A/S* and the Soviet organisation *Arktik Ugol*. In 1950 the Norwegian collieries operating were at Longyearbyen (Adventfjord), Sveagruva (Van Mijenfjord, closed by 1960) and Ny-Ålesund (Kongsfjord) for Tertiary coal and the Russian, at Grumantby (Colesbukta), for

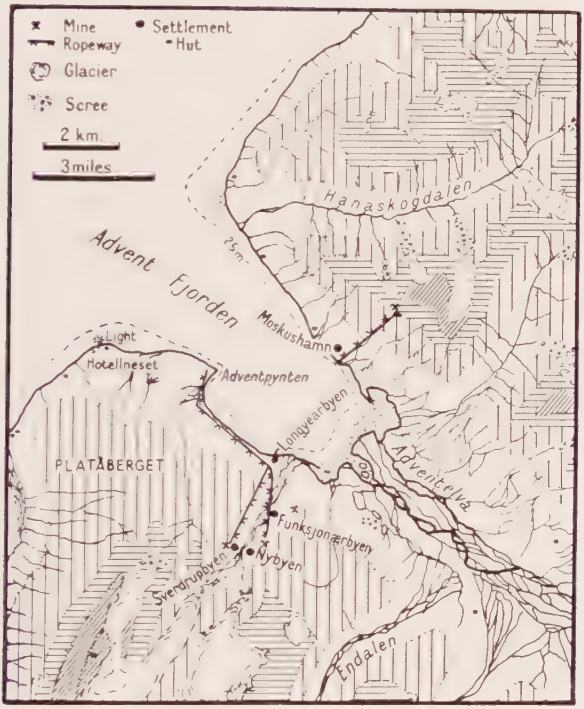


FIG. 104.—ADVENTFJORD.

This was the site of the first significant coalmining in Spitsbergen and considerable capital has been spent to permit mining.

1. Sverdrupbyen 2. Nyben 3. Funksjonærbyen
4. Longyearbyen 5. Moskushamn

Based, by permission, on *Norge Topog. Kart over Svalbard, 1 : 100,000*, Blad C, Adventdalen, 1950

Cretaceous coal and at Barentsberg (Grønfjord) for Tertiary coal and at Pyramiden (Billefjord) for Carboniferous coal.

Because of the unique environment of these collieries details are given of the more important features of the individual workings. Probably the most important in its effect on the exploitation was the colliery established in 1904 by John Longyear, of Boston, Massachusetts, on the west side of Adventfjord. His company, the Arctic

Coal Company, displayed typical American energy and founded Longyear City 400 ft. (120 m.) above sea-level, the Tertiary coal being carried down to the shipping-point by wire ropeway. The coal seam is rarely more than about 3 ft. (1 m.) thick, yet the output is 3 tons a shift per worker[1]; conveyor wagons carry the coal from the working-face to the adit entrance and thence it is taken for 5 miles (9 km.) by this telpher-line which can carry 75 tons an hour. Temperatures in the mine remain constant at about 25°F. (−4°C.) on

FIG. 105.—MINING AT SVERDRUPBYEN.

Coal miners' houses with water supply in insulated pipes on trestle. In the background, set in the scree-mantled slope, is the gear of an adit mine.

account of the *tjäle* zone and it is only below this frozen zone, which extends down 900 ft. (275 m.) in the mountains, that there is trouble with water. After producing 147,000 tons the mine was closed in 1915 on account of wartime difficulties. In 1916 the company sold its rights to the *Store Norske Spitsbergen Kulkompani A/S* of Oslo which opened a second mine on the other side of Longyeardalen. In 1920 there was an explosion and a new pit was opened in the 1930s higher up and on the west side of the valley, and about the same

[1] Compare with 2½ tons a shift per worker in Scotland (1953).

time a modern loading plant, which can take alongside ships of 11,000 tons d.w., served by an aerial ropeway, was constructed at Hotellneset. A new mining community, Sverdrupbyen, was created at this last mine. There used to be a settlement at Advent City, established by the British *Spitsbergen Coal and Trading Co.* which carried on mining for a few years from 1905, but the log huts were removed in 1916 to Hjorthhamn by *A/S De Norske Kulfelter Spitsbergen* which had purchased the property. The mine was abandoned for regular working in 1921 as the Cretaceous coal was poor and the mine was 1,600 ft. (480 m.) above sea level. During the war the whole of the settlement serving the Adventfjord mining area was destroyed by the Germans in the attack by the *Tirpitz* and *Scharnhorst* except for the area farthest from the shore. Water for Longyearbyen is taken from an adit and heated before being passed through well-insulated pipes supported on a timber-framing above the floor of the valley, which is deluged with icy-cold meltwaters.

From 1917–25 a Swedish company, *Svenska Stenkols A/B Spetsbergen*, worked Sveagruva with a steadily increasing output, but, with the decline in world prices the output did not cover costs in 1924–5. In 1925 a fire broke out, which is still burning, thus preventing further work at the original mine, where there was good coking coal. The claim-right on this wind-swept plain was purchased by the Norwegian company in 1934 and, despite destruction by the Germans, the town was rebuilt and the second mine reopened after the war only to close in 1949 when the company concentrated upon Longyearbyen. Van Mijenfjord suffers from the presence of the island of Akseloya which, with the adjacent shallows, bars its mouth and causes ice jams, resulting in a very short shipping season. Further, although there is a long pier, the largest colliers touch bottom when loaded and so can only leave at high tide.

The third of the Norwegian collieries is at Ny-Ålesund, where the mine was first opened in 1917. It has certain advantages, including seams up to 7 ft. (2·1 m.) thick but the district is faulted and the accumulation of gas culminated in a firedamp explosion in 1929, after which the mine was closed. Longyearbyen mine has also had serious explosions. As it was not damaged in the military operations, working was resumed after the war and a coal-cleaning plant installed. The coal is carried to the loading quay, which can accommodate vessels of about 3,000 tons, by a tiny railway which is the most northerly in the world. Kongsfjord has an advantage as a shipment point in that the waters do not close with ice every winter. All the Norwegian mines are now owned by the State.

The Russian workings were initiated on an appreciable scale soon after the establishment of the Soviet Union. At Grumantby, on

Isfjord, mining was commenced in 1919 by the *Anglo-Russian Grumant Co.* but the colliery closed from 1926–31. Unfortunately there is no good harbour and loading has to be from lighters.[1] Barentsberg colliery was established in 1909 by Norwegians, sold in 1920 to a Dutch company who sold it in 1932 to the Russians. The large pit at Pyramiden, acquired from a Swedish Company in 1932, was opened in 1937, while the two older collieries have been modernised since the war so the Russian outport is entirely won by modern

A.C.O.] [*August, 1955*

FIG. 106.—LOCAL BOAT, ADVENT FJORDEN.

This local boat, with crow's nest for ice observation, is leaving Longyearbyen. The pylons above the cliff edge carry coal from the mines to the loading point at Adventpynten.

equipment from shallow mines unlike the Norwegian adit type. By the use of icebreakers, the shipping season from these collieries has been extended until Christmas.

The shipping season from the Norwegian collieries is from mid-May until after the end of October and this is much longer than it used to be for lighthouses, radio beacons, and a land radar station have helped to defeat the dark, foggy autumn days which used to force ships to return to Norway without their cargo of coal. In very bad years for ice, such as that of 1915, the ice may never clear in

[1] In 1948 the Russians were constructing a new loading pier on a protected bay and it was to be connected with the Grumant mine by an electrified railway.

Isfjord. The Norwegian collier fleet in 1949 consisted of sixteen vessels of 1,800 to 7,000 tons which in the winter season traded in north-western Europe.

Potential markets for the production of coal are relatively close—Iceland and the northern zones of Russia, Finland, Norway and Sweden (through Narvik)—but some has been carried to Oslo, Kobenhavn, Stockholm, and the Netherlands. Understandably, the Norwegians have analysed the potential market, excluding that of the Soviet Union, and in 1938 and 1959 the total coal imports into the most interested countries were (in million tons):

	1938	*1959*
Norway*	2·5	0·27
Sweden	6·0	1·76
Iceland	0·5	0·03
Finland	1·5	1·03
	10·5	3·09

* Since the war Norway's coal imports have been reduced by about one million tons.

From 1907–61 Spitsbergen exported 14⅕ million tons of which the nearest consumer, Norway, took 9 million tons (a small quantity of which was re-exported to Sweden). Therefore it would seem as if production of these good quality coals could be greatly increased. Unfortunately frost action pulverises the coal in storage dumps to the size of gravel and plans for a briquetting plant are being discussed.

The output of Svalbard coal by companies of various nationalities is of some interest as showing the great output possible in a few years despite difficult conditions, not the least of which is the tendency of the miners to become dispirited during the dark winters in almost all-male communities.

Production to 1937

Nationalities	*Years operating*	*Total output, '000 tons*
Norwegian	1917–37	4,495
Russian	1931–37	1,212
British	1907, 1920–6	66
Dutch	1921–25	192
Swedish	1918–25	445
American	1907–15	147

(Based on A. Hoel, *Polar Record*, 1938, p. 85.)

Population

No traces of pre-historic occupation have been discovered in the archipelago and the first recorded successful wintering was that of

the marooned English sailors in 1630–1 while the second, in 1633–4, was by a party of Dutchmen left there to protect the whaling base from marauders. Other attempts by Dutch and Russians failed because of scurvy but gradually Russian and Norwegian hunters organised themselves to withstand the conditions. With the formation of the coal companies it was necessary to winter men in considerable numbers: in 1907, 107 men were working the coal, in 1924, 1,500, in 1930, 439 and in 1938, 2,653; in recent years 3,000 to 4,000 people, of whom over half are Russians, have wintered in Spitsbergen. In 1949-50, 1,004 persons wintered at Longyearbyen compared with 676 in 1938–9. Whilst the miners generally live in barracks, some are accompanied by their wives and families, though the children have to go for later schooling to Norway. Longyearbyen, the capital of Svalbard, has over a thousand inhabitants and here are kept a few cows—the milk being reserved for children and invalids—and about a hundred pigs for winter meat. This town, besides barracks for the miners, has a hospital, school, church, a radio station and cinema, for it is found that the miners require distractions during the winter to offset nostalgia. Before the war communications with Norway were maintained in summer by a vessel which traded between Tromsø and Longyearbyen (taking three days for the voyage), and then coastwise to Ny-Ålesund.

The most northerly settlement, the "town" of Ny-Ålesund on Kongsfjord, used to be a calling-point for cruising liners, and between 1937–9 there was an hotel which was open from June until the end of August. Formerly these cruising liners used to visit Adventfjord, though it was a place of little charm compared with the magnificent sea- and landscapes at King's Bay, but Ny-Ålesund was more suitable for seeing the edge of the polar ice-field.[1] An hotel stood from 1896 to 1905 at the entrance to Adventfjord. Superficial as such a visit was, many were able to feel some of the charm of these islands with their glaciers and peaks and austere clarity of sky and sea. Beechey well described the attraction of the archipelago:[2] "In cloudy or misty weather, when the hills are clothed with newly-fallen snow, nothing can be more dreary than the appearance of the shores of Spitsbergen; whereas, on the contrary, it is scarcely possible to conceive a more brilliant and lively effect than that which occurs on a fine day, when the sun shines forth and blends its rays with that peculiarly soft bright atmosphere which overhangs a country deeply-bedded in snow; and with a pure sky, whose azure is so intense as to find no parallel in nature."

[1] These cruises were resumed in 1955.
[2] Beechey, *op. cit.*, p. 52.

BJØRNØYA (BEAR ISLAND)

74° 20′–74° 32′ N.
18° 46′–19° 18′ E.

Situated near the southern end of Spitsbergen Bank, 122 miles (195 km.) from Spitsbergen and 200 miles (320 km.) from Norway, is

FIG. 107.—BEAR ISLAND.

Contours interval 50 m. (164 ft.); lakes are stippled. Inset is a plan of the former mining settlement at Tunheim. The wind-rose in the top right-hand corner is for Austervåg and the pecked line shows the approach for ships to this exposed anchorage.

Based, by permission, on map in "The Survey of Bjørnøya, 1922–31" *Norges Sval. og Ishavs Skrift.*, Oslo, 1944.

the fog-shrouded island known now as Bjørnøya. Discovered in 1596 by Barents in the search for the North East passage, and named Beeren Eylandt (Bear Island), it was also located by Stephen Bennet in 1603 and named Cherie Island in honour of his patron, Sir Francis Cherie. This tiny outpost of polar terrain, only 68¾ sq. miles (178 sq. km.) in area, is shaped like an inverted triangle. It has a similar structure to that of Spitsbergen, namely a foundation of rocks of the Cambro-Silurian Hecla Hoek formation in the south and horizontal later rocks of Devonian to Triassic age. In the north is a low, rocky plateau studded with hundreds of lakes and varying in height from 100 to 350 ft. (30–106 m.) with abrupt cliffs up to 160 ft. (48 m.) high. The eastern side of Bjørnøya is dominated by the Triassic rocks forming the three peaks of Miseryfjell, 1,758 ft. (536 m.), and the south by several mountain summits of which the highest is Hambergfjell, 1,444 ft. (440 m.). During the Quaternary period the island was lower in relation to the sea-level but, having been raised by some 500 ft. (150 m.), marine erosion has been active and many detached pillars and stacks have resulted.

Bjørnøya is situated at the meeting of the warm current of the North Atlantic and the cold Arctic current, and therefore it is a region of fogs. There are, on the average, only seven really clear days in a year, and 82 days of fog; a fogbank can persist for over a week without a break. In winter, from December to March, there is an average of three days with gales each month but these gales help to disperse the fog and so the winter months are the least foggy. The mean temperature for March, the coldest month, is 15°F. (−9·4°C.) with the minimum recorded −26°F. (−32°C.) and the mean July temperature 40°F. (4·4°C.) with a maximum, which occurred in August, of 61°F. (16·1°C.). During most years July sees the sea free of ice though this pack ice has been known to remain all summer; however, the island is not so beset by ice as is Spitsbergen and therefore could have a longer shipping season. With steep cliffs and few beaches from which the interior can be gained Bjørnøya lacks a sheltered harbour. There are no glaciers on the island.

The severe climatic conditions result in poor soils and a scanty vegetation. However, the ledges of the cliffs teem with sea-birds during the nesting season, while the banks surrounding Bjørnøya, particularly extensive to the north, are rich with halibut and cod. The waters less than 100 fm. (180 m.) deep are frequented for trawling. After the English re-discovery of the island, walrus were hunted, but they were either driven away or exterminated by the slaughter. Later, whaling activities made the island better known. From the eighteenth until the early nineteenth century, Russian trappers

visited it to hunt foxes. Later there was a whaling station on the shores of Kvalrossbukta which was used from 1905–8 following the prohibition on whaling from Norwegian shores.

In 1898 a German company lodged a claim for the Carboniferous coal, the existence of which had been known since 1610, but two years later the claim was abandoned. From 1915 a Norwegian company worked Devonian coal from seams 2 ft. to 2 ft. 3 in. (60–70 cm.) thick which could produce an excellent metallurgical coke, but the chief use was as bunker coal for the coasting steamers of northern Norway. The Carboniferous coal was more difficult to exploit and of poorer quality. By 1925 some 116 thousand tons had been mined and shipped at Austervåg on the north side of the island but in that year working ceased as prices were too low. The mining settlement was Tunheim, which at the period of maximum activity housed 260 persons, but the huts were abandoned in 1925 except for the wireless and meteorological stations and now only three men winter in the island. At Austervag there was a coal-loading structure with mooring-rings but it was unsafe with easterly winds. While the island offers potentialities in coal resources the drawbacks of fog or storms and lack of suitable harbour sites seem to prohibit a revival of mining.

JAN MAYEN ISLAND

70° 51′–70° 10′ N.
7 55′–9 05′ W.

This small island of 145 sq. miles (372 sq. km.) lies 250 miles (400 km.) east of Greenland and 300 miles (480 km.) north-north-east of Langanes in Iceland. It would seem reasonable, from the time of forty-eight hours' sailing given in the Icelandic Landnámabók, that this was the Svalbard (*Cold Coast*) of the Norse and not Spitsbergen as claimed by modern Norwegians. Present knowledge of this island dates from the first quarter of the seventeenth century when ships of several nationalities called and gave various names:

1607	Henry Hudson . .	English.	Hudson Tutches.
1611	Thomas Marmaduke .	English.	Trinity Island.
1612	Jean Vrolicq . .	French.	Île de Richelieu.
1614	Jan Jacobsz May .	Dutch.	Jan Meys Hoeck [name given to a cape but by Blaeu applied to whole island. At first the mate, Joris Carolus, of one vessel named the island after himself, Joris Eylandt.]
1614	Jan Jansz Kerckhoff .	Dutch.	Mauritius [name used by Dutch during whaling period].
1615	Robert Fotherby .	English.	Sir Thomas Smith's Island.

There is doubt about the veracity of the first two English reports and it is considered now that Hudson could not have sighted Jan Mayen Island in 1607, but that about this year ships from Hull were here and kept the discovery secret. Rumour of the new discovery became credited, by the chroniclers of this period, to Hudson. The Dutch Noordsche Compagnie left documentary proof of the discovery by two of their ships in 1614. Robert Fotherby visited the island in 1615 and his detailed description, the first in English, was printed in *Purchas His Pilgrimes* and gives an excellent account of the island.[1] "This Iland is about ten leagues in length, and stretcheth North-east and South-west: it is a high Land, and at the North end of it there is a Mountayne of a wonderful height and bignesse, all covered with Snow, which I called Mount Hackluyt [Beerenberg], the base or foot of it on the East side is almost foure leagues long, it hath three such sides at the base lying out to the Sea, and from the fourth side doth the rest of the Iland extend it selfe towards the South-west, which is also, as it were, a place fortified with Castles and Bulwarkes, for on each side there bee three or foure high Rockes which stand out from the Land, appearing like Towres and Forts. It lyes in the parallel of 71 degrees, where the Needle varieth from the true Meridian Westwards eight degrees. The Land is generally só farre as I have seene, Rockie and very barren and worse than the Land that I have seene in King James his New Land, under eightie degrees, [Svalbard] for there is no grasse but mosse, and where I first landed upon low ground, all the stones were like unto a Smith's sinders both in colour and forme, [volcanic ash] the sand is generally mixed with a corne like Amber [olivine]; the Beaches are abundantly stored with drift wood [from Siberia] and many stones like Pumis, which will swimme on the water. I saw many traces of Foxes and the footing of Beares, but not any signe of Deere or other living creatures, and very small store of Fowle."

Jan Mayen Island has been claimed by different nations at various times when the value of its location was considered of significance. In 1618, James I gave a monopoly to a Hull Company to catch whales at Trinity Island and in 1630 Île de Richelieu was claimed for the French crown. In 1929 it came under the sovereignty of Norway after the establishment of their weather and wireless stations.

Since the seventeenth century the island has been visited by a number of observers who have left published records of their observations on this outlier. In the eighteenth century Laab (a German): in the nineteenth, Scoresby (British), Quannersted (Swedish), Lord

[1] Robert Fotherby in *Purchas His Pilgrimes*, Hakluyt Society Edition, XIV, 1906, pp. 86–7.

Dufferin (British), the Austrian Polar Party, in the twentieth J. M. Wordie (British), Bird (British), the Imperial College, London, Expedition (British), the Louise A. Boyd Expeditions (American). Knowledge has not only accumulated from such visits, often short and hurried, but also from the meteorological party maintained by the Norwegians since 1921.

The island, which is 30 miles (53 km.) long by 2–11 miles (3–17 km.) wide can be divided into three physical regions: the north-east, central and south-west. The north-east is formed by the giant lava cone of Beerenberg which, 30 miles in diameter round the base, rises to Haakon Peak, 7,471 ft. (2,277 m.) and has on the lower flanks many subsidiary cones formed of ash or lava. The central region is comparatively low and is the denuded stump of an ancient volcano; here steam rises on occasion from fissures, and Scoresby reported seeing an eruption in 1818. It was on the shores of this central area that the former whaling stations were established and the modern weather station stands. The south-west region is one of confused and higher relief, and recent vulcanicity has dammed lakes with the lava streams advancing towards the sea. The volcanic ash gets blown to sea but a portion is arrested by the waves and forms sandbars smoothing the coastline. The island is subject to earthquake shocks.

FIG. 108.—JAN MAYEN ISLAND.

This volcanic island rises sharply from oceanic depths and culminates in Beerenberg, 7,471 ft. (2,277 m.).

Based, by permission, on J. M. Wordie, "Jan Mayen Island", *G. J.*, 1922; E. G. Bird, "Jan Mayen Island", *G. J.*, 1935; E. G. Bird, "Imperial College Expedition to Jan Mayen Island", *G. J.*, 1939, and Louise A. Boyd, *op. cit.*, Plate IV.

Climatically this is a windswept, unfriendly region and one of the early voyagers in these seas reported, "The *Island* of John Maien bore from us south-west and by west, as near as we could guess within ten miles. We might have seen the island plain enough, but the air was hazy, and full of fogs and snow, so that we could not see

far."[1] The lowest recorded temperature has been −22°F. (−30°C.) in December and the highest 59°F. (15°C.) in July and August, while means, probably unreliable owing to the short period of accurate observations, are lowest in March at 21°F. (−6°C.) and highest at 42°F. (5·5°C.) in August. Humidity averages about 85 per cent and the cloud-cover eight-tenths in all months. Fog is a handicap with an average of thirteen days in August and an average annual total of 58, that is nearly one day in six foggy. The southern part is seldom free from summer mists for more than a few hours at a time. Fog is not so frequent in winter as in summer but this season has most of the 32 days in the year with winds of Force 9 or over (44 knots, 23 m. per sec.) on the Beaufort scale. Precipitation is not more than about 16 inches (400 mm.) in a year but as most falls in months when the mean minimum temperature is below freezing point it is sufficient to nourish the ice-cap of Beerenberg, without resulting in appreciable flow of the glaciers.

The crater of Beerenberg, over a mile in diameter, is filled with ice and from it bursts the Welprecht glacier, by way of the destroyed lip on the north. The snowline on the southern slope is at about 3,000 ft. (900 m.) but is lower on the northern flank. Evidence has been found that the glaciers are shrinking now but there is no trace of a glaciation other than the present; this may be either because the island has come into existence since the main glaciation or because rapid erosion has obliterated glacial features. The former explanation is the more likely, for the glaciers rest in shallow depressions and not in well-developed valleys. Frozen soil is found in the summers at a depth of about 2 ft. (60 cm.). Vegetation also finds it difficult to obtain a foothold on the blowing, volcanic sands and the soil-less talus slopes. Reindeer are not found in the island, possibly because of its remoteness, but it may be because of the scanty supply of fodder.

Soon after the discovery the Dutch whalers erected vats along the west shore to boil down the blubber and by 1618 nineteen Dutch ships were whaling off Jan Mayen Island, compared with three in 1614. The store houses were pillaged by Basque pirates, so an attempt was made to winter a guard-party, but with the decline of whaling this was no longer necessary and there are no minerals to encourage settlement. There is some hunting of blue and white foxes, but with the reduction in numbers, the Government has had to control the catch; the occasional polar bear is still caught. On this island there is some difficulty over water-supply owing to the porosity of the volcanic rocks.

[1] F. Marten's *Voyage to Spitzbergen*, Hakluyt Society, London 1855, p. 3; entry for 27th April, 1671.

Since 1921 the Norwegians have maintained their weather forecasting station with four men. In 1940 a vessel equipped to relieve the meteorologists foundered on the reefs so the station was abandoned. The Germans attempted to land a small force but the ship was driven ashore and in 1941 a small Norwegian force was set ashore to defend against possible attack, but all that was experienced were air-raids. To supplement food, seals were caught, seabirds shot and eggs collected, while the men were allowed to retain the fox pelts as their own property, for hunting helped to reduce the melancholia of the dreary winters. Jan Mayen Island has thus served as a base for several activities of Europeans, but its total potentialities are slight and its present use little; and this is not merely because there are extreme difficulties in landing.

CHAPTER 12

THE FÆROES

61° 26′–62° 24′ N.
6° 15′–7° 41′ W.

GENERAL DESCRIPTION

Life within the Færoes is rigorous, in response to the natural conditions, which provide only a poverty-stricken agriculture and little opportunity of exploiting mineral wealth; the hardships are, however, ameliorated by the rich harvests from the sea. The archipelago extends for 65 miles from north to south and for 40 miles from east to west; this compares with 70 and 40 miles respectively for the Shetland Islands, their nearest comparable land area. Sunnbiarsteinur (Munken), the southernmost rock of the group, is situated $3\frac{1}{2}$ miles ($5\frac{1}{2}$ km.) south of Suðuroy and some 150 nautical miles (277 km.) north-west of the Shetland Islands and rather less than this north of the Butt of Lewis. The group consists of 22 main islands, of which seventeen are inhabited, and there are, in addition, a number of smaller islands and rocks, making the total area 540 sq. miles (1,399 sq. km.). The archipelago has had home-rule since 1948 but still retains political connections with Denmark.

The Færoes rise from the Wyville-Thomson ridge which connects Scotland and Iceland, and from this ridge there is a sharp drop down on either flank to the oceanic depths of the Norwegian Sea and the North Atlantic Ocean. Without many skerries or reefs, the land rises precipitously from the sea and appears clearly as the remains of a deeply eroded plateau with a surface at about 1,000 ft. (300 m.). Pyramidal peaks and sharp ridges rise above this plateau surface and reach over 2,000 ft. (600 m.) with the highest point in the archipelago, Slættaratindur, in the island of Eysturoy, 2,894 ft. (882 m.).

Most of the islands are elongated along a north-north-west to south-south-east axis, which is also the direction of the sounds and fjords which so penetrate the land area that no part is more than three miles (5 km.) from the sea. Charts reveal that there are no great depths within the fjords or close to the archipelago—an elevation of 33 ft. (10 m.) would join Eysturoy to Stremoy—but that the 100 fathoms submarine contour is never more than 20 miles from the coastline. While the waterparting of the group generally is eccentrically situated near the western edge, most of the islands have

steep slopes falling from a mountainous ridge: only in the larger islands of Suðeroy, Streymoy and Eysturoy is there any diversity of surface pattern but even in these islands little flat land occurs.

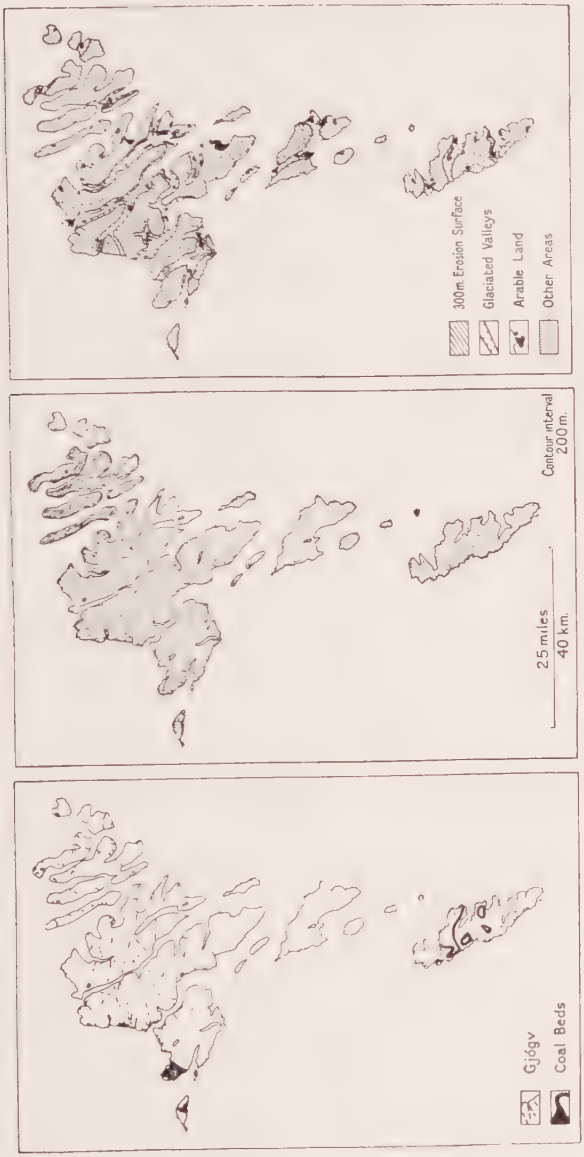


FIG. 109.—SURFACE FEATURES OF THE FÆROES.

The left-hand diagram shows by short lines the clefts known as *gjógv* (geos) and by the black area the coal districts. The middle diagram has contours at 656 ft. intervals while the third summarises the geomorphological features.

Based, by permission, on *Atlas over Danmark*, 1949 and on Danish maps of the Færoes. Geology from Walker and Davidson, Geikie and Simpson.

Owing to the similarity of their geological structure, the mountains show little variety of feature: whether the tops are the truncated remains of a peneplain at about 1,000 ft. (300 m.) or are notched into peaks and pyramids, the flanks everywhere exhibit a terraced character with vertical walls of bare basalt, known as *hamrar*, rising one above the other and usually separated by short intervening scree and erosion slopes, called *brækker* or *lier*, lightly covered with grass and moss. Many of the hamrar scarps below about 1,000 ft. (300 m.) are obliterated by screes. The highest areas are found within a mile of the north and north-west coasts, hence steep and high cliffs drop towards these coastlines whereas the plateau surface slopes towards the south-east, providing lower land more suitable for settlement.

Several of the valleys carved in the plateau are comparatively broad in proportion to their length. Some, when followed upstream from the head of a fjord, rise gently until they suddenly terminate in a broad, open corrie; others ascend by broad steps, each shaped like a shallow corrie, to the base of the mountain ridge. Occasionally two valleys meet head-on and so provide low cols through the mountains; an example of these through dales is Saksunardalur which joints Saksun on the west coast of Streymoy, to Hvalvík on the east coast with a col summit of 230 ft. (70 m.). On the mountain flanks there also appear isolated corries and from these collecting hollows, many of which enfold rock-basin lakes, numerous streams carrying much sand tumble down to the valley or sea below. Scattered across the archipelago are numerous lakes, most of which occupy rock-basin hollows, the cover of superficial deposits being thin or absent altogether.

GEOLOGY

The geological structure is very simple, for the principal rocks are bedded basalts, individually not exceeding about 100 ft. (30 m.) in thickness, but known to aggregate 14,000 ft. (4,270 m.) above the lowest exposed horizon; intercalated with them are layers of tuff and, in Mykines and Suðuroy, clay, shale and coal. The dip is generally towards the east, the oldest of the basalt series outcropping in the two islands where sedimentary deposits occur. These older basalts, anamesitic, are dark blue to black and of fine-grained material except in the bottom and top layers of individual flows which are usually scoriaceous. Between the basalt layers are beds of tuff, up to 32 ft. (10 m.) in thickness, composed of a fine-grained grey or reddish material burnt by later basaltic flows. Lenticular bands of dark carbonaceous shales and clays, laid down in lakes on a former basalt surface, occur in Mykines and Suðuroy; in the latter island

dark, fine-grained intrusions occur and it is probable that their incoming destroyed some lignite seams. The basalts younger than the coal deposits are generally more coarsely crystalline than the older basalts and are doleritic in character. The lava beds are lenticular and, as seen from the impressive cliff sections of Kallsoy and Kunnoy, die out rapidly when traced laterally. These basalts were emitted from innumerable minor vents or from fissures, and not from a few central volcanoes. Along the west coast of Streymoy the sea has sectioned a number of the vents and it can be seen that the volcanic orifices, choked with ejection breccia, were later buried under basalt flows from other vents.

Numerous vertical dykes and sills of a compact basalt occur in the northern isles and, because of their well-developed system of jointing, are rapidly eroded to form caves and geos. Even in the interior areas, away from marine erosion, deep clefts or *gjogvs*, up to a kilometre long, with perpendicular walls, are formed along the outcrop of the dykes, while some of the through valleys, such as Kollfjarðardalur in Streymoy, owe their existence to zones of weakness provided by these dykes. Some of the harder dykes, however, now stand up to form a wall-rampart, the greatest of which, known as Jatnagardaðar ("Fence of the Giants"), is on the island of Vágur.

Basalt plateaux, of which these islands form a unit, were created from Greenland to Spitsbergen and Scotland in the so-called Thulean Province during the Oligocene or Miocene periods. The aggregate thickness in the Færoes is at least seven times that of the equivalent rocks in Skye. James Geikie, arguing from the easterly dip, believed that the centre of volcanic activity lay between the Færoes and Iceland but this cannot be accepted as more than conjecture, for the region has been racked by immense earth-movements since Miocene times. It is certain that the Færoes represent only the shreds of a once extensive plateau surface. Although the fresh basalt is tough, it is readily decomposed and blocks freely break off along the well marked joints and bedding planes. Some beds, especially those through which water percolates, are quickly eroded and thus even the strongest of beds can be undercut. At Tjørnuvík, at the north of Streymoy, such great masses of debris fell in about 1876 that most of the improved farm lands were destroyed while frequent stone avalanches caused the desertion of the township of Blankskáli, on Kallsoy in 1807. The rate of erosion has been tremendous and it can be demonstrated that within the area of the archipelago the amount removed from this geologically young plateau exceeds the portion left as land. At present the characteristic ice-worn relief is rapidly vanishing and the pre-glacial features are re-appearing.

Everywhere in the islands, below the level of the higher ridges,

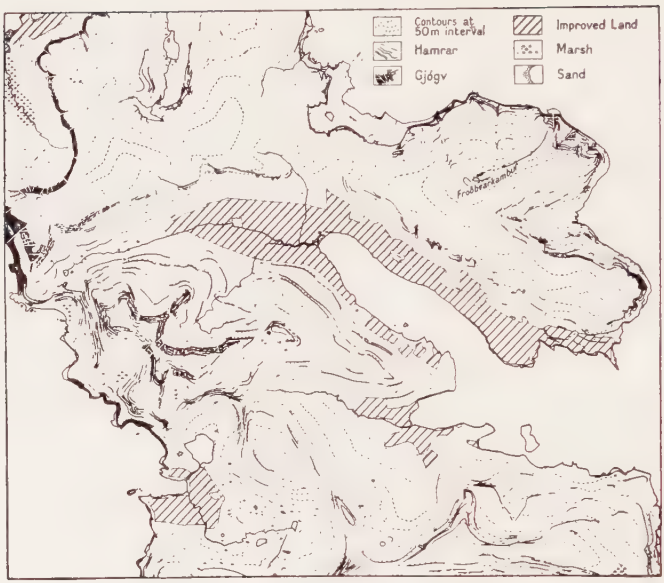


FIG. 110.—SURFACE FEATURES OF FROÐBØUR, SUÐEROY.

FIG. 111.—ROCK OUTCROPS AND LOOSE ROCKS.

FIG. 112.—SURFACE DRAINAGE.

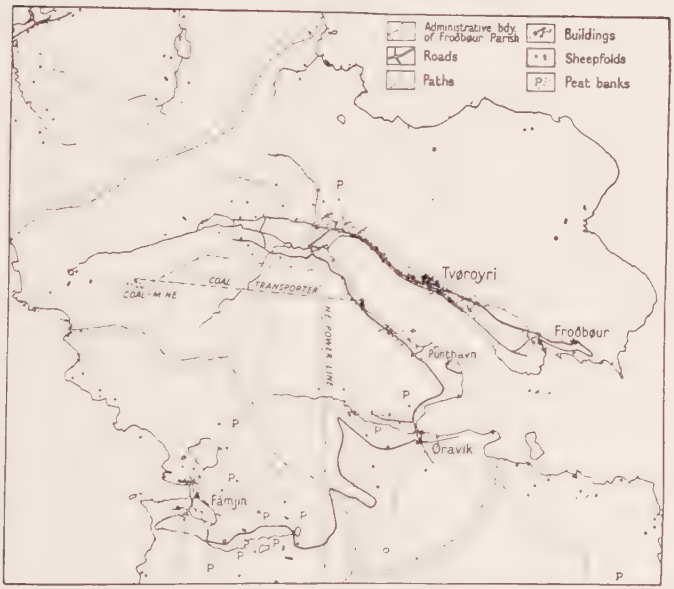


FIG. 113.—SETTLEMENT FEATURES.

Figs. 110–113 are based, by permission, on Geodætisk Inst., maps on a scale of 1:20,000. They show very clearly the characteristics of the Færoese scene although the human activities are abnormal in the working of coal. These maps should be compared with Figs. 133, 166, 167 and 183.

there are conspicuous marks of glacial action. Frost action has started to remove striæ on the *roches moutonnées*, and indeed the general form of many of these is being masked by fragments of frost-shattered debris. All the evidence points to the local origin of the ice rather than to an ice-sheet advancing from the north or having contact with the Norwegian *mer de glace*; this local ice faithfully followed pre-glacial valleys which were eroded along dykes and along the master-joints which originated by torsional stresses during the Pliocene uplift.

By comparison with the smoothed rocks of the ice-abraded lower land, the higher districts, above about 1,400 ft. (430 m.), are rough and rugged as a result of the action of frost and of ice plucking on the ridges which stood as nunataks above the ice and névé.

The boulder-clay resembles that of the Scottish Highlands in that it is found as patches in the lee of projecting rock masses and as a cover across the valley floors. Much of the till, which seldom exceeds 18 ft. (5 m.) in thickness, is a tough, dark-brown clay deposit containing lenticles of sand and gravel. Glacial erratics are of common occurrence but some of the many loose boulders on the surface may be due to the freeing by frost leverage in post-glacial times of blocks which dropped to lower land under the pull of gravity.

COAST LINE

The coasts are usually precipitous and many of the islands have only a few places where landings can be made: Stóra Dímun, for example, has but one landing place and this can be used only in calm weather while on the 19 miles (30 km.) of the west coast of Suðeroy there are but three places where a landing can be effected. The island of Mykines may be isolated for months at a time because there is no proper anchorage. The western and northern coasts, exposed to the heaviest seas and also nearest the watershed, have the most magnificent cliffs: for example, on the island of Streymoy at Mýlingur the nearly vertical cliffs and hamrar rise to 1,870 ft. (570 m.), and at Kunoyarnakkur, the northern promontory of Kunoy, to 2,690 ft. (820 m.). Since the joints run parallel with the cliff-front the cliffs are kept young and fresh in appearance by the breaking away of any semi-rotten material at the face. Features of marine erosion are abundant, with all stages visible from the first opening of dykes and master joints, through the development of caves, geos and large stacks to their ultimate erosion to skerries. Landt, writing in 1800, described Sunnbiarsteinur (Munken) as being 75–100 ft. (23–35 m.) high but in 1887 it was undermined by wave action and

collapsed until there was only 30 ft. (9 m.) above the sea. In other areas tradition reports that what are now only rocky pinnacles once supported many sheep; marine erosion has removed large portions of former islands.

All the evidence goes to show that the land has sunk in the post-glacial period, and unlike most of Scandinavia, there has been no uplift to produce raised beaches. Fjords occur in the archipelago; although shallow throughout they are characteristically shallower at their entrances than near the heads. The straits between the islands show the usual features of fjords and in addition a shallow section continuing the line of the watershed on the adjoining land; in effect these *sunds* are two fjords with a flat, submerged col separating them and bear the characteristics that the through dales would have if they were submerged.

Although the watershed is close to the west coast, the longest river is only some five miles long. With a dominant primary, parallel pattern some of the streams are being deflected along the master-joints which produced the geos and the surface drainage pattern is becoming more complicated. The flow of water varies from almost nothing in a dry period to a tumultuous spate after heavy rain. It was partly because the pre-glacial watershed was close to the west coast that only small glaciers moved westwards and thus few fjords were formed on that coast. Some of the fjords provide water sheltered from the ocean swell but are not suitable for anchorages as they are subject to mountain squalls known as *Fjeldkasten*: in many of the havens mooring-rings are let into the rocks near the anchorage for making warps fast and to prevent vessels dragging their anchors. The only anchorages considered safe in winter are Kongshavn and Fuglafjørður (Eysturoy), Trongisvágur and Vagsfjordur (Suðuroy), Vestmanna (Streymoy) and Klakksvík (Borðoy): several of these have developed as fishing ports in recent years. Vestmanna is one of the best natural harbours of the islands and is better than that of Tórshavn which is inadequately protected by the island of Nólsoy.

In spite of the small tidal range of under eight feet the tidal currents are of great importance; the main stream to the north-west is called the Vestfald and that to the south-east the Eystfald. In the narrow sounds the velocity approaches 9 knots and this, together with the many eddy currents, due to the irregular rocky floors, makes inter-island communication difficult; moreover, because of the steep ridges separating districts even townships on the same island—all having a seaboard location—may have to depend upon boat connection. A curiosity of the sea-current movements occurs at Vedvík (Wood Bay), on Viðoy, where driftwood from Eurasia is piled upon

the foreshore but is difficult to utilise as there are not even footpaths connecting the shores of the bay with the townships which lie across the hills.

CLIMATE

The warm, moist air from the Atlantic meeting cold air streams from the Arctic and, in winter, the cool land, produce fog and mist on one day out of seven during the year and one out of three in the months of June and July; the actual tendency to fog is even greater than is suggested by the published statistics, which relate to Tórshavn, since many local fog patches occur, particularly on the western side of the northern isles. From June to August the air temperature is higher than the sea temperature, but in the rest of the year the sea warms the air; in either case the difference in temperature increases the liability to fog-formation. The sea approaches can be made difficult by the frequent fogs but, fortunately, the only outlying danger is Sunnbiarsteinur (Munken rock). The annual precipitation is about 60 in. (150 cm.) with the maximum fall from October to March; the large total reflects the high relief, and the north, with its greater elevation, receives more rain than the lower south. Rain falls on three out of four days throughout the year but, although it is well dispersed on the average, records show that falls of over two inches (50 mm.) within twenty-four hours have been recorded in seven months out of the twelve. Snow falls frequently but rarely lies long, except on the summits of the highest mountains, although it may destroy sheep flocks and cause avalanches. According to tradition the farm of Gerðar, in Borðoy, was three times wiped out by snow avalanches before the present, less exposed, site was selected. With the strong maritime influence, the winters are milder than the latitude would suggest and a thin coating of ice forms only occasionally at the heads of quiet fjords: the phenomenal drift of icebergs south of the Færoes in 1903 was derived from Arctic ice. Relative humidity is high and cloudless days are rare: the average cloud cover is 7–8-tenths through the year and this affects hay and peat drying and crop ripening. The frequent changes of air-mass associated with the Polar Front make the weather extremely variable although the mean seasonal figures show little range: the difference between the mean temperatures for February and August is only 13°F. (7°C.) while the range between the mean maximum and minimum daily temperatures for any month does not exceed 11°F. (6°C.). Features of this maritime climate are summarised in the Table opposite.

Climatic Statistics for Tórshavn

	Mean air temperature		*Actual maximum temperature*		*Actual minimum temperature*		*Mean sea temperature*		*No. days of frost, average*	*Hours of sunshine daily, average*	*Precipitation*		*No. of rainy days, average*	*No. of foggy days, average*
	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.			*in.*	*mm.*		
January	37·8	3·2	54·2	12·3	14·8	−9·6	42·2	5·6	12	0·3	7·2	183	28	1
February	38·2	3·4	51·4	10·8	12·4	−10·9	41·8	5·4	11	0·2	5·7	146	25	1
March	37·8	3·2	56·4	13·5	11·0	−11·6	42·0	5·5	12	0·3	5·7	145	26	1
April	42·0	5·5	57·2	14·0	16·6	−8·5	43·8	6·5	6	0·7	3·5	88	20	3
May	45·0	7·2	64·4	18·0	24·8	−4·0	46·0	7·7	3	1·0	3·6	91	20	6
June	49·6	9·7	67·6	19·7	30·4	−0·9	48·6	9·2	0·2	1·3	3·1	79	18	9
July	51·6	10·8	70·2	21·2	34·0	1·1	50·4	10·2	—	0·3	3·6	92	21	11
August	51·4	10·7	69·2	20·6	34·8	1·5	51·2	10·6	—	0·8	3·9	101	19	9
September	48·8	9·3	61·6	16·4	24·9	−3·9	50·2	10·1	0 4	0·5	5·3	135	22	5
October	44·0	6·6	58·0	14·4	21·8	−5·6	48·0	8·8	4	0·2	6·9	176	26	3
November	40·6	4·8	53·6	12·0	14·6	−9·6	45·5	7·5	8	0·5	6·9	175	26	1
December	38·2	3·4	53·4	11·8	13·0	−10·5	43·4	6·3	12	0·2	7·2	182	28	1
Annual	43·8	6·5	70·2	21·2	11·0	−11·6	46·1	7·8	69	6	62·6	1,593	279	51

[Based on C. H. Ostenfeld, *Botany of the Færoes*, Vol. 1, 1901, pp. 32–7]

VEGETATION

With so much of the northern isles rising over 1,000 ft. (315 m.) and with a heavy rainfall, high humidity and strong winds,[1] conditions are inimical to plant growth. Furthermore, owing to sheep nibbling, it is only in ravines or on lake islets and in gardens that the vegetation is at all upstanding. Sandoy and Suðeroy are lower, have a less rigorous climate and are more fertile. Kirkjubøur (in the south of Streymoy), Sandur and Skálavík (in Sandoy) and Stóra Dímun (on which there is only the house of one family), are regarded as the four richest areas in the Færoes because the grass grows well and sheep can feed off it all the winter. Generally, the islands have a sparse cover of grass and heather; thus they look bare, and like the Shetland Islands are destitute of trees except in private gardens and small enclosures.

Landt in his account of the Færoes, published in 1800, reported on the failure of tree-planting experiments in the previous decade. Since then a successful plantation has been established in the outskirts of Tórshavn and it is found that rowan (*Sorbus scandica*), maple, elder and larch grow best but become mis-shapen through wind nipping the young shoots. The flora of the Færoes bears a greater resemblance to that of Norway and of Scotland than to that of Iceland. In the basal portions of the peat deposits, which are principally composed of sphagnum moss, occur fragments of brushwood; sticks of juniper and birch, of two inches diameter, are frequently found. This brushwood suggests that in immediate post-glacial times, when the islands were of greater extent, the climate was warmer.

SETTLEMENT AND OCCUPATIONS

Tradition has it that when the Vikings first settled in the islands in the ninth and tenth centuries they found a colony of Celtic monks. The Irish monk Dicuil, writing in A.D. 825, in *De Mensura Orbis Terræ*, describes the archipelago as "consisting of small islands separated by narrow sounds, on which for about a hundred years there dwelt hermits who had come from our fatherland Scotland [i.e. Ireland]: but even as these islands from the creation of the world until then lay waste, so are they now, on account of the Norse pirates, deserted by these anchorites; but they swarm with innumerable sheep and an extraordinary number of seafowl". The Viking

[1] On the flat tops of the hills the strong winds blow the disintegrated rock fragments about and, except in the lee of rocks, strip the surface of vegetation. The mean wind force recorded for every month except July and August is 4 on the Beaufort Scale, (i.e. 13 knots, 8 m. per second).

settlers, who emigrated to avoid the rule of Harald Haarfager, came from the same districts of Norway as did those who emigrated to the Shetland Islands, hence the similarity in the "Norn" of the Færoese and Shetlanders. In the More and Agder district of Norway, from which the main stream of migration came, the people to

FIG. 114.—TRADITIONAL FÆROESE COSTUME AT TÓRSHAVN.

this day have the least characteristic "Scandinavian" features and this may account for the Færoese having such a marked dark strain. It is probable that the earliest settlers, with the eye for country possessed by the Vikings, occupied the more fertile southern portion. Along with the Shetland Islands, the islands came under Norwegian control in about 1035 and remained with Denmark in 1814. In the economic development of the archipelago the turning point was

undoubtedly the abolition in 1856 of the Danish Crown trading monopoly. The Færoes were occupied by the British in 1808 as well as from 1940–5. War has tended to pass by this isolated archipelago but the Second World War did have a great influence, one of the most useful relics of the occupation, particularly in Vágar, being roads, constructed originally to serve air bases.

Of the resources of the islands farming, although of low value, used to form the core to the economy. Apart from the modern towns created for fishing and trading functions, the life of the community centred on the coastal townships where agriculture was practised. Round the township buildings stretch the infields (*bø*, or called *trø* if recently cultivated) and these, the only tracts once cultivated, do not aggregate four per cent of the total land area. The cultivated land was separated from the hill-lands (*hagi*, equivalent to the *scattald* in the Shetland Islands). As in the Shetland Islands the land was originally held in common but the cultivated land is now divided; traces of the past, however, are seen in the stringent common grazing regulations. The land was held on lease from the Crown (now a Færoese trust), by freeholders or by tenants in new settlements. Each holding of cultivated land, except that rented in new settlements, carries the right to grazing, to fowling on the cliffs, to seaweed collection and to a share of the caa'in whales captured.

The cultivated land has been largely made from the moorland by removing boulders, by carrying soil and turf from the valley bottoms and by fertilising with seaweed. The fields, situated on the less steep slopes near the fjords where the soil could accumulate or be improved, are long and narrow (mostly only some 10 ft. (3 m.) broad) and divided by ditches. As a result of these ditches and successive diggings the fields in cross-section had a saw-tooth profile but with the virtual abandonment of cultivation the surface is slumping to a smooth outline. A feature of the traditional Norse freehold (odal) holdings is the splitting into many parcels of land within a township. At a few places there has been within this century re-distribution of the land to consolidate the parcels and this made it possible for ploughing to take the place of slow and tedious digging. In time, with the sharing among odal heirs, these parcels will again be split among various owners and need re-grouping; but this contingency is less likely with the reversion of the land to grass than if cultivation had continued. The crops were a hardy barley, a little oats, potatoes, turnips and angelica (grown in small enclosures in former days). The patches in the infield used to be planted for two years in potatoes (or rarely turnips) and then for the third year in barley (or rarely oats) mixed with grass-seed obtained by sweeping the barn-floors. Hay has always been the most important crop. The

natural grasslands give a more nutritious hay than those of Iceland, and it is taken off for some eight years before moss chokes the grass and the next cultivation is needed; formerly grain and potatoes broke the grass rotation but now only potatoes are used. The hay is used as winter cattle feed but much difficulty is experienced in drying it. Since 1911 the Scandinavian method of drying on fences has been used, but on account of the strong winds it is not regarded as a completely successful solution. With practically no barley now being grown[1] seaweed, which is unsuitable for potato growing as it leads to rotting, is not so much used as a manure. Potatoes have become the only field crop and occupy over five per cent of the infield area. Because of the cloudy skies and high humidity, grain crops do not ripen and the sheaves of still green corn were partly dried with the heads hanging over the ditches and then the ears were dried, with heat, in the drying house (*sodnhuse*) so as to be ready for grinding.

While a few cattle are tethered close to the village most wander over the hills in summer and are milked there; the yield is so low that the women can easily carry the produce back to the townships in pails or on their backs. The annual output of milk is too low to be satisfactory—Færoes 257 gal. (1,170 litres), Iceland 323 gal. (1,470 litres), Norway 352 gal. (1,600 litres), Denmark 638 gal. (2,900 litres)—and attempts are being made to increase the yield. To meet the needs of the fishing population there has to be a considerable import of condensed milk. At the end of the summer grazing season the animals are allowed into the infield after the hay has been taken off. Of far greater value than the cattle are the sheep which resemble the Icelandic breed; as the old Færoese proverb says, "Sheep's wool is the gold of Færoe" and much wool is still exported to Denmark: in 1951, 46 tons. The relative proportions of the principal livestock are interesting when compared with the neighbouring areas of the Shetland Islands and Iceland.

Livestock per Thousand of Population in 1898 and 1960 for Shetland Islands, Færoes and Iceland

	1898			*1960*		
	Shetland Islands	*Færoes*	*Iceland*	*Shetland Islands*	*Færoes*	*Iceland*
Cattle . .	678	296	327	350	152	273
Sheep . .	3,468	6,990	6,144	13,343	1,818	4,517
Horses . .	201	46	550	67	?	176

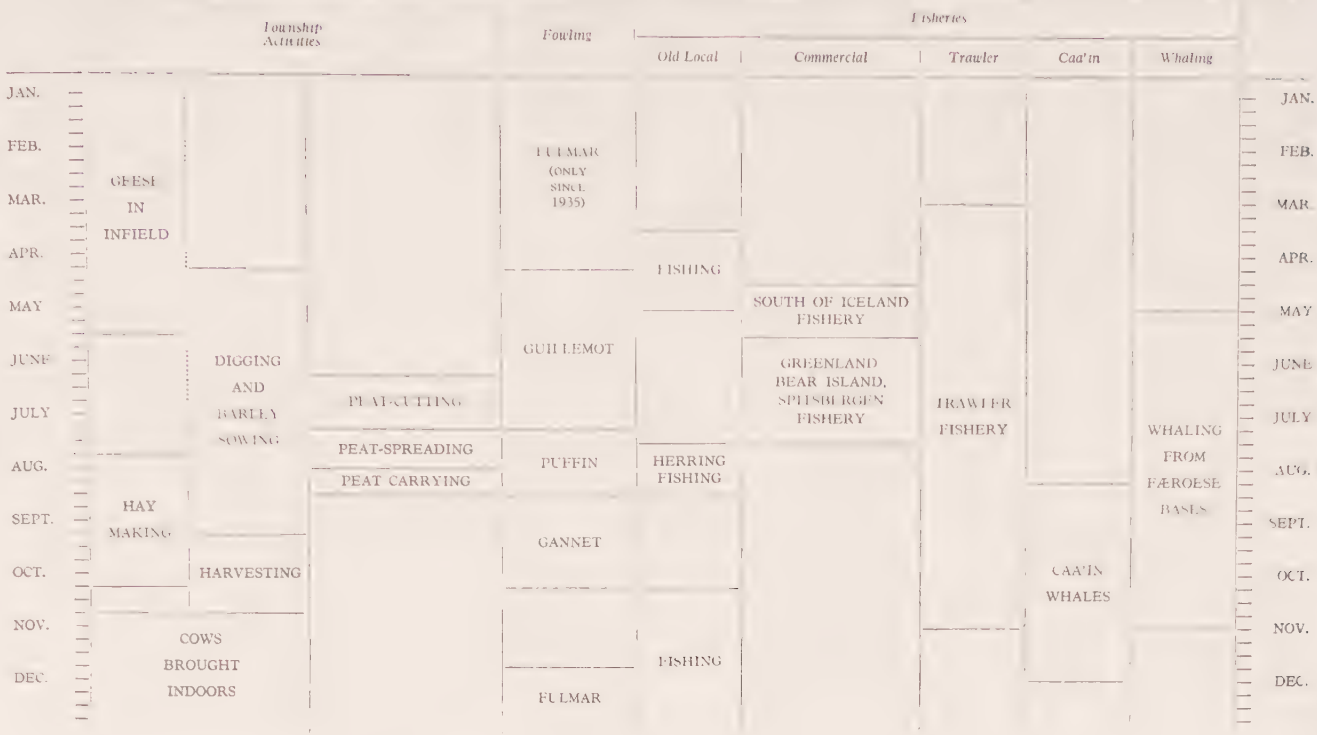
[1] In 1900 about 800 acres (320 ha.) were under grain as compared with ten times that acreage of land off which hay was taken.

This Table reveals how, relative to population, interest in sheep has declined in the Færoes whereas it has greatly increased in the Shetland Islands; there are insufficient cattle in all three island areas. While horses are still an important element in the livestock of Iceland they are declining in all these areas. Most of the Færoese sheep are owned communally but there is an increasing interest in private ownership, which encourages the improvement of the flocks as regards weight of carcase and wool but may lead to deterioration in the quality of the latter. The wool is plucked by hand and not shorn; this is yet another similarity with Shetland practice. About 30,000 sheep and lambs are slaughtered annually for consumption within the islands.

On all the islands, except in Suðuroy where coal is mined, and in the largest towns where coal is imported, peat is the source of fuel although the peat cover is much thinner than in the Shetland Islands. The Færoese are more careful over replacing the surface sod, in order to ensure the maintenance of supply, than are the inhabitants of some of the outer Scottish islands where the ground is "scalped" in peat working and both the grazing and future supply of peat imperilled. The seasonal activities are summarised in the Table opposite from which it can be seen that the agricultural season from March until October is a busy one.

The very rigorous conditions which prevail make life in the islands difficult, and many adaptations to the environment necessary. The traditional type of house is a low stone building, half sunk in the ground and surrounded by stone walls to give protection against the wind. The old houses had no glass windows and the living room was warmed by an open peat fire. The next stage of development was that of the wooden house thatched with green turf which continues to grow. During and after the Second World War, with the shortage of timber, concrete has been used for the walls, and for the roofs synthetic materials such as asbestos sheeting. During the winter the men help to comb and spin the wool as the women are too busy with township work and cleaning the fish to cope with all the processing of wool. The islanders in the past used to dye their woollen cloth with macerated lichens. As in the Shetland Islands, meat was preserved by drying in drystone enclosures, and while there were primitive water mills, much of the grain was ground in hand querns.

Mineral wealth is a minor element of the economy. In Suðuroy a coal seam $1\frac{1}{2}$ metres thick is worked by an adit and sent by aerial ropeway to the fjord side and thence by motor lorry to the town (see p. 471). There is a sea-level working at Hvalbøur to the north of the main mine. Native copper was worked in mediæval times on



[Based on K. Williamson.]

Nólsoy from the zeolites in the basalt but the quantities were insignificant. From the steam cavities beautiful specimens of calcite crystals, chalcedony and opal have been obtained: the semi-precious opal, not of high grade, has been obtained in appreciable quantities at Kollafjørður, in the island of Streymoy. The porous basalts are very little used for construction within the islands, but attempts have been made to export the stone to Denmark and the United States for building and monumental purposes.

From time immemorial sea fisheries have provided a valuable item of diet while, in this century, they have become the principal cash income for the islanders, nine-tenths of the value of all exports being taken up by fish. Some of the larger banks are well away from the islands and in pre-trawling days many lives were lost with sudden

FIG. 115.—OLD STYLE COD FISHERIES.
This is a reduced facsimile of the obverse side of the 5 kroner note.

summer gales. After the abolition of the Danish trade monopoly in 1856 the Færoese developed the klipfish (air-dried cod) trade. In the 1880s they adopted, from the Shetlanders, the technique of fishing with well-smacks. Later, as the local banks proved inadequate to maintain the catch with British as well as Færoese vessels fishing intensively, they extended their fishing to off Iceland and Greenland. Cod and halibut were the main catch using lines baited with whelks and mussels, but since 1906 trawlers have operated on the sandy banks. Most of the pre-war export, which more than doubled in the inter-war years, was to the Catholic Mediterranean countries in the form of dried fish: for example, in 1937 5,205 tons went to Spain, 1,990 tons to Italy, 894 tons to Portugal, 786 tons to Great Britain, 223 tons to Denmark and 7 tons to

Norway. The export to the north European countries was of green salt fish, not dried hard. In recent years great efforts have been made to enter the South American market which requires a smaller cod dried very hard. The open-air drying of the fish takes two months

FIG. 116.—AGE AND ORIGIN OF FÆROESE FISHING FLEET.

Each dot represents one fishing vessel—in the upper diagram by date of building and the lower by place of construction. Many of the vessels were second-hand when acquired by the Færoese and it will be noticed how they provided a market for older vessels as the more prosperous fishing communities acquired new vessels. After 1945 some very old trawlers were purchased from Iceland but these appear by their place of construction because they were second-hand when acquired by Icelanders.

Based on *Almanakki, 1953*, Tórshavn, 1953.

and is laborious, for the split fish has to be stacked and covered during every shower. A drying plant has been installed at Klakksvík but even so it is found that a partial drying in the open salt air improves the product. Throughout the 1939–45 war, the islanders, unlike the Icelanders, continued fishing and sent the iced fish to Aberdeen: at

the price of a toll of lives[1] and craft big profits were made which were used to buy second-hand trawlers from Iceland and to build modern trawlers in Britain. With the decline in prices since the war, it has been found necessary to sell some of the older trawlers. At present there is a considerable interest in the herring fisheries to the north of the Færoes. The shoals of large herring formerly caught off Iceland seem to have deserted these waters and the Færoese hope to expand their fishery which in 1960 produced 8,800 tons of salt herring and of fishmeal for export. Another marine industry is the catching of whales and this falls into two categories: the caa'in whale (*Globicephala melæna*) and the larger whales. The former patch is the one which enters most into the economy of the islands for the whales are driven into shallow bays and slaughtered in numbers up to a thousand at a time; the produce is divided proportionately among the inhabitants of the district and the participants. Each whale yielded about 30 gallons of oil which was used in jute manufacture and lamps; the flesh was used for meat, some being dried or salted, while the offal was utilised for manure and the skins for leather. Under modern conditions the oil is not extracted, the offal is dumped in the sea and but little leather is made, nevertheless the catch is still eagerly made to supplement the meat supply of the islanders. The numbers caught in any one year vary tremendously. In 1843, a peak year, 3,143 were caught, but the average annual catch fell in 1885–94 to 480; in recent years it has averaged about 1,200. The Fin and other whales could only be caught after the invention of the harpoon gun, and the Norwegians commenced the catching of these in 1894 from several shore stations in the Færoes. This brought but little revenue and benefit to the islanders for the ship-crews, who were most highly paid, were Norwegians as also were those at the Færoese-owned station established at Hvalbour, in Suðuroy, for catching *Balæna rostrata*. When the Norwegian Government, on account of the supposed threat to the herring fisheries, prohibited the operation of whaling stations in Norway, the Færoese bases became more important; in 1904 there were six stations which caught 409 whales. This type of whaling ultimately became insignificant as the whales were over-caught. The Danish Government required the Norwegian stations to sell, at a low price, all the whale meat the islanders required. In 1952 the two last whaling stations were closed because of economic difficulties although in post-war years they had been producing 1,600 tons of whale-oil and 700 tons of whale-meat and meal from the catch.

[1] The Klakksvík memorial to fishermen lost at sea is a grim record both to the normal hazards of fishing and to the abnormal losses during war.

An industry which may be regarded as marine is the sea-bird fowling which forms an invaluable supplement to the livelihood of the islanders. It is an extremely dangerous occupation; during half a century about ten per cent of the male deaths were due to accidents at sea or on the cliffs, even though the climbers use a rope. Puffins are caught by a hooked pole and kittiwakes and guillemots by a fowling net. The birds are salted or dried for winter use and the feathers collected for sale. Mykines island is one of the greatest fowling centres in the world; the inhabitants of this small, isolated island, surrounded by high cliffs, and having no other resources, are dependent upon the bird wealth for their subsistence. In addition to the carcases, eggs are collected and for this activity Stóra Dímun is the main centre. Eider-duck down is only collected at two centres where the birds nest in colonies. In 1910 about a quarter of a million puffins, guillemots and kittiwakes were taken annually: it required about thirty puffins or twelve guillemots to produce a pound of feathers.

As a result of the changes in the economy, the population has been able to increase without too great a pressure on land resources. In 1801 the population of the islands was 5,265; in 1906, 16,349, and in 1960 about six times the 1801 figures. In this century the rate of increase of population has been greater than that in Denmark and a significant factor in the age-composition is the great proportion of children. At Klakksvík in 1900 the school had a handful of children and one teacher, in 1953 600 children and eighteen teachers. This centre is not however completely typical in that there has been an exceptional development of the fisheries with subsidiary industries such as canning and wool spinning. There is no doubt that without the fisheries, the islanders would have been forced to emigrate in numbers or else would have faced destitution. As a result of the fishing industry settlements have grown until Klakksvík (Borðoy) Tvøroyri and Vágur (Suðuroy) each have over 2,000 inhabitants and Fuglafjørður (Eysturoy) and Vestmanna (Streymoy) over 1,000. The largest of the settlements is that of the capital town, Tórshavn. The scenery around this town resembles that of Loch Long in Scotland. "Several fishing sloops lie at anchor, but there is no appearance of a town. Here we are told is Thorshavn, the capital of Færöe—the haven of Thor. As we approach we discover that it is a town, the chief part of it built upon a rocky promontory which divides the bay; we can also distinguish the church and fort. The green tint we had observed is grassy turf—but it happens to be growing on the roofs of the wooden houses; and the houses are scattered irregularly among the brown rocks. . . . Beneath the fort and all round, split fish are spread on the rocks to dry; many square

fish-heaps also are being pressed under boards, with heavy stones above them."[1]

This is a picture of the chief town nearly a century ago and with the traditional houses built half of stone and half of wood with turf roofs, the grass of which was sometimes cut for hay, the character was that of any Færoese village. The number of houses gave the

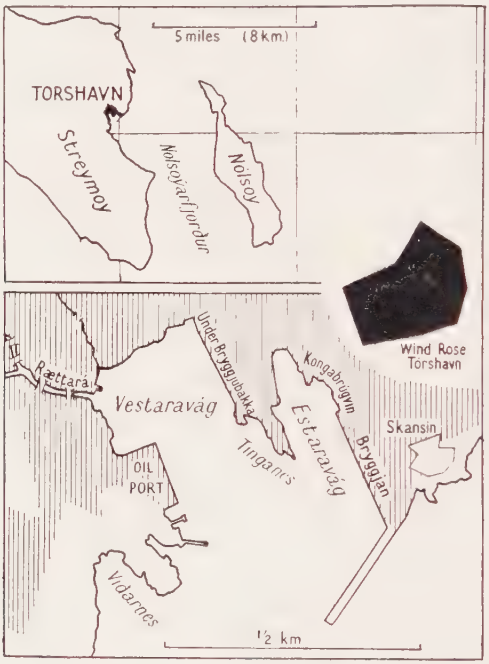


FIG. 117.—SITE OF TÓRSHAVN.

The upper diagram shows the imperfect protection provided by Nólsoy and the lower the new breakwater constructed during the post-war period, from near the old fort of Skansin, to protect the port from south-easterlies. The built-up area is ruled. Tórshavn is 62° 0′ N. and 6° 45′ W.

Based on local map of Tórshavn by F. Eriksen and F. Nielsen, 1950 and, for Wind Rose, on Admiralty Sailing Directions.

appearance of a greater population than actually inhabited them, for there were separate structures for drying the corn, drying the fish and meat, for storing peat and hay and the inevitable boathouse. To-day, the appearance has changed, cement and corrugated iron sheets replacing traditional materials. Now with a population of over 6,000, about eight times the number of inhabitants at the time of the above description, the town still appears strange to British

[1] A. J. Symington, *Sketches of Faroe and Iceland*, London, 1862, pp. 18–19.

eyes, with the bright colours of the painted wood, the narrow streets, the irregular siting of the houses and the green grass roofs. The harbour is not naturally well endowed, for in heavy seas vessels have to seek refuge at Kongshavn in Skálafjørður, Eysturoy; and though a road leads westwards to the western shore, that to the north is still incomplete so the capital is isolated, except by sea, even from much of the island on which it stands. Even as late as 1929 there were only two motor cars on the islands; this is not very surprising as at that date the total road mileage was two miles (3½ km.). Now there

A.C.O.] *[July, 1953*

FIG. 118.—ONE OF THE LAST TRADITIONAL BUILDINGS IN TÓRSHAVN.

Lava block basement (whitewashed at front and tarred at end), tarred board walls and turf roof. In this house near Skansin is still the old style kitchen.

are about 600 motor vehicles running on the 70 miles (112 km.) of roads. Small as are the total figures this means that the vehicles per mile ratio is one of the highest in the world.

The Danish Government aided the construction of the new breakwater and other construction works and also in the purchase of a trading steamer which plies regularly on the 971 nautical miles (1,800 km.) of the route between København and Tórshavn. There is a regular, but infrequent connection, by a Dutch company, with the Low Countries but communication with Britain, other than by fish-carriers, is irregular and infrequent. As a result of the political connections and transport links, there is a considerable Færoese colony in Denmark.

CHAPTER 13

ICELAND

63° 23′–66° 33′ N.
13° 28′–24° 32′ W.

GENERAL DESCRIPTION

Iceland, together with a few outlying islands, covers 39,961 sq. miles (103,500 sq. km.) and so is only second in size, among the European island groups, to the British Isles. The republic[1] lies 178 nautical miles (330 km.) from the east coast of Greenland, 243 nautical miles (450 km.) from the Færoes and 513 nautical miles (950 km.) from Norway. In popular estimation abroad, Iceland suffers from its misleading name for, in fact, only one-eighth is ice covered, and only a small part lies within the Arctic Circle. The greater portion of the country is a plateau with a surface 2,300–3,300 ft. (700–1,000 m.) above sea-level; cut into this surface from all sides are valleys and coastal lowlands which form only about one-fifteenth of the area.

The main plateau, formed of palagonite and porphyry, culminates in the south-east, with the highest point Öræfajökull, reaching 6,955 ft. (2,119 m.). This interior plateau is trenched by many valleys, with long spurs of residual upland forming the interfluves. Isolated mountains rarely occur; those which are not of recent volcanic origin are relics of the denudation of a former high-level plateau district; their edges are often fretted by erosion into fantastic shapes. This interior region appears wild for even under the most favourable conditions vegetation grows for less than three months in the year.

In the north-west is an outlier of plateau terrain deeply trenched by fjords and the sides of these, cut into a hundred layers of massive basalts, are so steep in their rise to about 2,600 ft. (800 m.) that settlements built to exploit the sea fisheries and fowling can only be established on the narrow raised beaches or on alluvial fans: in many respects this region of Iceland resembles the Færoes. The deep inlets of Breiðifjorður and Húnaflói have an isthmus only

[1] As from 17th June, 1944, Iceland was declared a republic after a plebiscite had been taken. Prior to that it had been united with Denmark under a common Crown, from 1918 onwards.

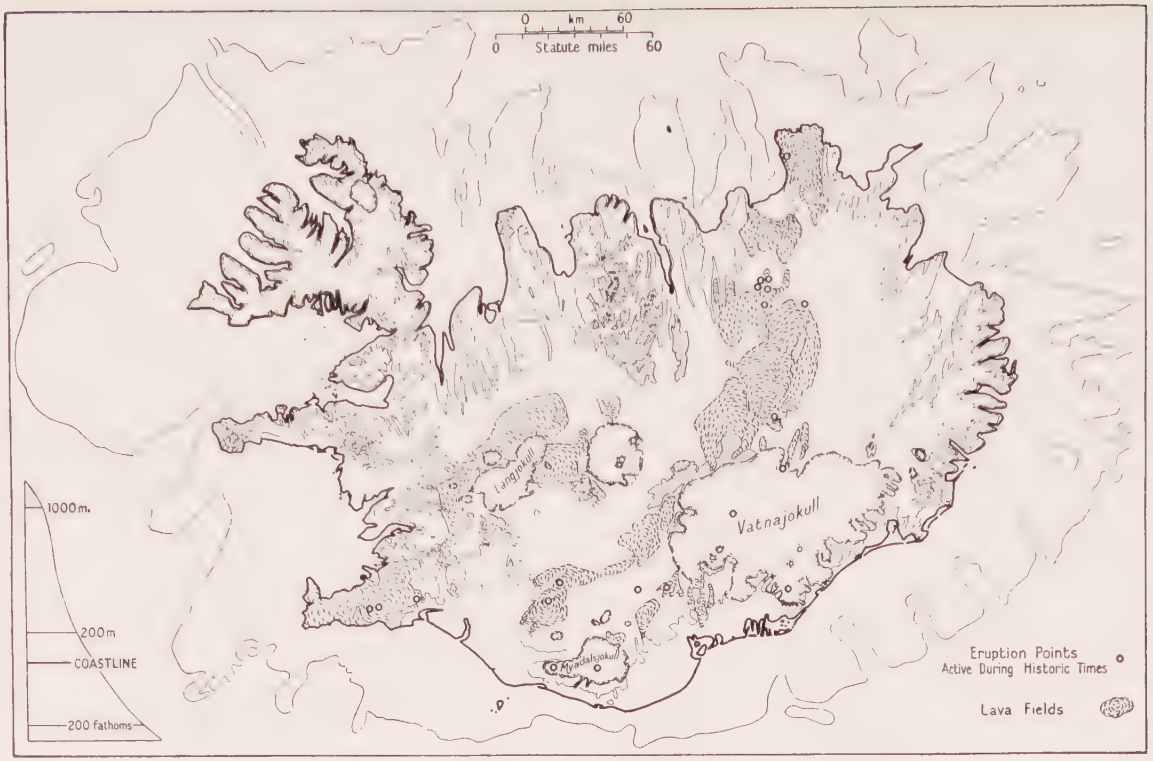


FIG. 119.—RELIEF MAP OF ICELAND WITH LAVA FIELDS AND VOLCANOES.

The sea shallower than 200 fathoms (366 m.) is the area significant in the fisheries. The sections of the coast where the 656 ft. (200 m.) contour comes close to the shore are those where settlement is most difficult. The western part of the Reykjanes peninsula should not have lava symbol. The lava field between the rivers Pjórsá and Ölfusá in the SW. is omitted.

Based on maps in *Islands Kortlægning*, København, 1944.

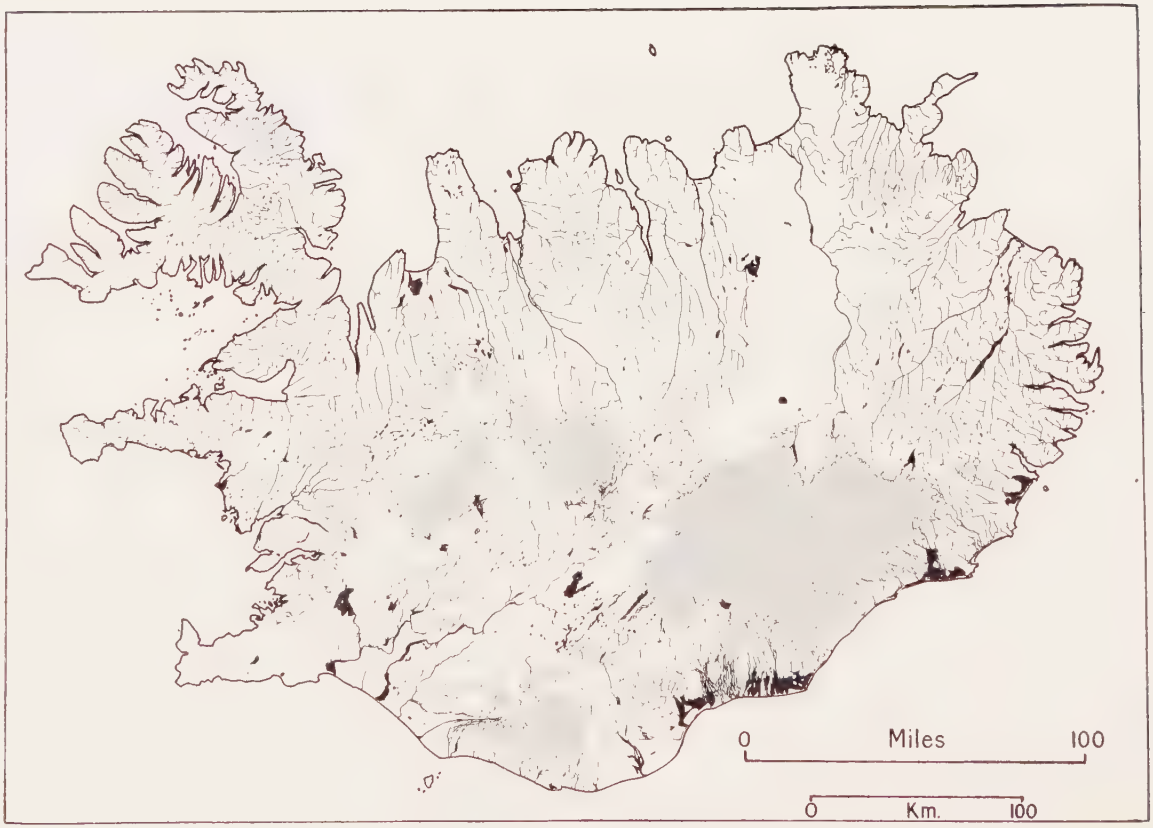


FIG. 120.—ICEFIELDS AND RIVERS OF ICELAND.

The stippled areas show the present icefields. From the pattern of the rivers may be distinguished the areas of the great lavafields while the braided lowlands of the south-east are conspicuous.

Based on maps in *Islands Kortlægning*, København, 1944.

4½ miles (7¼ km.) wide and rising to 750 ft. (228 m.) joining the north-western peninsula to the mainland so the area is isolated as regards land transport. On the north coast are broad fjords which open into wide valleys very different from the fjords of the north-west and east where mountainous terrain approaches the shore. By marked contrast the southern coasts are backed by large plains, crossed by the wide, braided channels of the lower courses of the fluvio-glacial rivers (jökulsá).

GEOLOGY AND VOLCANOES

Iceland is geologically a young country, for the oldest rocks are those of Eocene age, contemporaneous with the outpourings which created the plateaux of Skye and Antrim and the Færoes. The older Tertiary rocks consist of basalt layers, aggregating at least 20,000 ft. (6,100 m.) with intercalated beds of freshwater sands, clays

Geological Activity in the Mid-Northern Iceland Area of the Thulean Province

Quaternary	Glaciation and igneous activity.	Second volcanic period.
Pliocene	Deposit of marine sediments at Tjornes.	
Miocene or ?Oligocene	Tectonic disturbance, formation of the upland peneplain, its initial erosion and uplift.	
?Oligocene or Eocene	Outpourings of the Thulean Basalts.	First volcanic period.

[Based on L. Hawkes, 1938, p. 295.]

and lignites. These rocks have been faulted and differentially tilted and along the lines of weakness valleys have been carved by sub-aerial and glacial erosion. In the basalt districts the valley floors rise upstream by broad terraces with floors studded with small lakes and bogs. The heads of the valleys terminate in large corries, down the faces of which streams cascade. Tributary valleys frequently hang to a main valley and at the junction cones of alluvial gravels are forming. It was noted by Thoroddsen[1] that on the basalt mountains erosion is more active on the sunny flank and therefore the north-facing slopes are steeper.

Intruded into these basalts are sills, dykes and stocks which are part of the Pliocene and Pleistocene outpouring of igneous material.[2] Stretching across the island from north-east to south-west is a fractured belt of volcanic material including basalts, aggregating

[1] Thoroddsen, 1914, p. 213.

[2] L. and H. K. Hawkes have showed that Sandfell in eastern Iceland has a laccolithic structure similar to that of the Henry Mountains, Utah. It may represent an upwelling of magma which failed to reach the surface.

about 2,300 ft. (700 m.) in thickness. During historic times, volcanic activity in this belt has been as intense as that during the early Tertiary period: the volcano of Askja in 1875 ejected forty times the volume of material discharged by Vesuvius in 1794 and there have been other eruptions which have exceeded this volume.

In Iceland there are two especially well-marked systems of fissures: one is aligned from south to north and the other from south-west to north-east except in the Snæfell peninsula where the direction becomes east to west. These fissures have followed the boundaries

A.C.O.] [*August, 1938*

FIG. 121.—LAVA SURFACE NEAR MÝVATN.

In the middle distance is the dark mass of Hverfjall, the largest ash cone in Europe.

of the horsts of country which have withstood earth movements. Many of the centres of volcanic activity are associated with the fissure systems: for example, the enormous outburst of Mývatnssveit issued from this type of vent whilst the eruption of Askja in 1875 came at the intersection of two lines of fissures, whereas Ódáðahraun lava is of Hawaiian type. Many fissures, some of which have been traced for 50 miles (80 km.), are identifiable as clefts, known as *gjas*, which are from one to three yards wide and of indefinite depth. Not all the fissures are open along their whole length; for example, the Laki eruption of 1783 developed on an incompletely ruptured fissure. From about a hundred craters along this fissure

there was a lava field, over 220 sq. miles in area (565 sq. km.), the largest lava stream in historic times from a single eruption.[1] Sometimes instead of a linear fissure a circular depression is found and the volcanic material is ejected round the fractured edge of the depression. From some vents lava and cinders are ejected but others remain as open chasms. The lava may rise quietly but usually small cones form.

The volcano Hekla appears to have been built up along a main fissure with parallel subsidiary vents and from these lava and ashes issue. This centre of vulcanicity is well known because of its proximity to the settled plains of the south-west; it has had over twenty periods of activity during the past thousand years. In the vivid words of the Logmann's Annal[2]: "a fire broke out in Mount Hekla, so powerful that the mountain split in such a manner that it will be visible in Iceland so long as the country is inhabited. Large rocks moved about in this fire like charcoal in a blacksmith's hearth, and crashed together with so much thunder and noise that it was heard as far as the North Land and in many other places. So much pumice stone cast out on the Næfurhold farmhouses that their roofs were burnt off. The wind blew from the south-east, and carried the sand northwards across the country between Vatnsskarð and Öxarfjarðarheiði so thick, and producing so great a darkness, that no man knew if it was night or day, inside or out, while the falling sand covered the ground completely. . . . These two days nobody dared go fishing from the North Land on account of the darkness. This happened .iij˙ jdus Julij [1300]." The awe inspired by Hekla led to its being described on the Ortelius map of Iceland [1590] as "Hekla perpetuis damnata esti[us] Et niurb[us] horrendo boatu lapides evomit",[3] and it was regarded for centuries as the region of chaos round the gates of hell. Prior to the Hekla eruptions of 1947–8 there were earth tremors and noises for three or four days; these were followed in turn by the vapour phase, the bomb phase, by pumice and then by ash and flowing lava.

When the surrounding ground is flat, fluid lava spreads freely: thus the lava desert of Ódáðahraun covers 1,400 sq. miles (3,640 sq. km.), or, if the lava streams running north from Vatnajökull be included 1,690 sq. miles (4,390 sq. km.). It has been estimated that this

[1] Fine dust from this eruption caused peculiar refraction effects in the air and gave brilliant sunset across the whole of Europe to North Africa and western Asia. In Caithness the shower of ash destroyed the growing crops. As a result of this eruption 11,500 cattle, 28,000 ponies and 190,500 sheep perished; the following year 9,500 people (one fifth of the total) starved to death.

[2] S. Thorarinsson, *Geog. Annaler* 1944, p. 208.

[3] This, apparently corrupted in the engraving, may be taken as meaning: "Hekla doomed to perpetual heat and snow vomits stones with terrible noise."

A.C.O.] [*August, 1938*

FIG. 122.—MUD VOLCANOES AT HVERARÖND.

In the areas east of Mývatn are hot springs and mud volcanoes. The gully behind is stained with sulphur and other deposits and for some years steam has been tapped with equipment for extracting sulphur so by 1956 there were few mud volcanoes left.

single flood of lava would have covered Denmark to a depth of 16 ft. (4·8 m.). The lava usually spreads out to form a plain, with a corded and broken surface marked by ridges and clefts difficult to traverse; but sometimes, as in the district between the rivers Skjálfandafljót and Jökulsá, it may swell into enormous domes up to 9⅓ miles (15 km.) in diameter. Much of the land over which the lava has spread in historic times was unoccupied but there are numerous records of the destruction of farms: for example, "And that night there came up fire out of the earth, and burnt the Borgar-hraun. There was a homestead [Hripe] there then where the lava-mound now is."[1]

Volcanic eruptions have occurred under the sea and there are various records of islands appearing but being quickly eroded. The rocky area of Eldeyjarboði, 36 miles (57½ km.) south-west of Reykanes, is believed to be the remnant of such an eruption in 1783.

The large lava and ash cone type of volcano is rare in Iceland although at Hverfjall, east of Mývatn, there is the largest ash cone in Europe. According as to whether a district is formed of basalt or breccia the landscape varies: basalt mountains are usually sharp in outline and those formed of breccia soft. Where the basalt or dolerite has flowed over breccia the mountains appear tabular in appearance: flat-topped and with steep sides which have not eroded away so rapidly as the tuff-ridges.

Occasionally the volcanic activity develops under the ice-caps which still exist and then there occur great floods of dirty water with swirling icebergs, known as *jökul-hlaup*, from rapidly melted ice, and these help to form the sandy and stony plains which fringe the south and may cause devastation to settled districts. The Öræfajökul eruption of 1362, by this means, swept forty farmhouses with all their inhabitants and livestock into the sea. Following the Hekla eruption of 1947–8 it is estimated that there was about 4 million cu. yd. (3 million cu. m.) of water at the start of the *hlaup* (flood).

Other features of vulcanicity include hot springs with the particular form of the Stóri Geysir (Great Geyser), which has given its name to periodically spouting hot springs. Some of the springs contain sulphur and carbon dioxide but no commercial use is now made of these chemicals. It is known that the hot-springs occurred in Iceland during the Ice Age and that this enabled terrestrial animals to survive but there was no survival of Tertiary heat-loving flora. To-day the soil round the hot springs may be snow-free in winter and there is more green growth. Although there is a slight positive value to the islanders from the hot springs for heating glasshouses and as a tourist attraction, the negative value of the vulcanicity is far more pronounced, for the many square miles of rough lava

[1] *Landnáma-Bóc*, II, 5, 6.

desert, besides being sterile, hinder movement across the interior. Fortunately, the frequent earthquakes which accompany the vulcanicity and tectonic movements have not, owing to the sparseness of the settlement, been marked by major human disasters greater than that experienced in 1896 in the fertile southern lowland between Eyjafjallajökull and Reykjanes when every house received some damage and 161 farmhouses were destroyed. Soil is frequently stripped from the hillsides by earthquake vibration and the loss of pasture land may be serious.

LANDSCAPE FORMATION

One eighth of the area of Iceland is at present under ice, all of which is of the plateau ice-cap type though with outlet glaciers issuing from the largest caps. The névé line is some 3,600 ft. (1,100 m.) above sea level in the south, rises to 4,500 ft. (1,370 m.) in the interior, and descends to 2,000 ft. (610 m.) in the north-west. Since the ice-caps lie so high above sea-level with a considerable expanse of lower land separating them from the sea, no glaciers reach the coast. Although the moist air brought across the Atlantic gives the equivalent of 170 in. (430 cm.) of rainfall on Vatnajökull, the largest ice sheet in Europe, ablation from its surface is equal to 40 ft. (12¼ m.) of snow thickness a year; this great annual turnover differs from the conditions prevailing in Greenland. While most of the glaciers have been retreating in recent times, thereby freeing further areas of the valleys, considerable damage has been caused to the lower, settled sections by the rupture of ice dams. As the ice in the main valley lessened, lakes impounded in the side valleys burst, sweeping a flood of water and iceblocks over the lower course of the main valley.

There is no doubt that Iceland, like the rest of the Scandinavian World, experienced more than one glaciation, and there were warmer inter-glacial periods when birch and other plants flourished, followed by fresh advances of ice-sheets; with but a slight lowering of temperature Iceland would again be submerged by ice. At the time the plant-rich clays were deposited it is probable that the mean annual temperature was about 52°F. (11°C.) for maple, oak, sequoia and pines flourished.

Round the shores of Iceland are found the remnants of raised beaches; the highest recorded is about 610 ft. (200 m.) above present sea-level. The uplift may be due to the release of pressure with the melting of the ice cap but it was not a simple uplift and was accompanied by oscillations, for peat is now found *in situ* below sea-level.

The land surface of Iceland presents a bare appearance, partly because all the areas above 1,640 ft. (500 m.) are almost a complete

desert, and there are also local deserts at lower altitudes due to special circumstances such as blown sand and volcanic eruptions. The greatest single factor in the moulding of the surface, as we see it today, was glaciation; all aspects of this occur although, possibly owing to the smaller thickness of the ice cap, rock basins are rare and the fjords are much shallower than those of Norway. Certain post-glacial features, such as lava fields and volcanic cones, impart a roughness to the landscape, for they are little weathered. Most of the large lakes are formed in down-faulted areas. Some faulting has been so recent that actual fault scarps, as opposed to fault-line scarps, may be responsible for abrupt changes of slope. Other scarps are formed by the incision of valleys into old lava flows which then appear as cliffs in a valley section. Many districts are without a vegetation cover and large screes are formed by the severe frosts acting on the rock outcrops which have been stripped of the rotten-rock cover by glaciation. Even in a grassed area the frost heaves the ground into hummocks and so prevents the use of machinery in agriculture. Much of the subsoil remains frozen and natural drainage is thus impeded, whilst under frost action clay and stone polygons form and the soil movement in these, and in the hummocks, inhibits plant growth.

Wind action also is important in eroding and transporting the dust derived from volcanic ash, disintegrated tuff and fluvio-glacial deposits. The heavier fragments, which the wind cannot carry, remain to form gravelly flats known as *örfoka* whilst the tuff-dust carried away is sometimes deposited in loess-like layers known as *móhella*. Ash has been carried after volcanic eruptions and from the wastes of the plateau in such quantities as to bury pasture lands: the valley of Þjórsádalur, 10 miles (15 km.) north-west of Hekla, was rendered almost uninhabitable by being buried in pumice and lava. The volcanic ash from the eruption of Hekla in 1300 affected two-thirds of Iceland; the volume of ash was estimated at $1\frac{1}{5}$ cu. miles (5 cu. km.), equivalent to one-fifth of that volume in lava, and food production was so affected that there was a serious famine in 1301. After the eruption of 1947–8 fluor in the ash from Hekla poisoned the pastures and led to the death of sheep because it made their teeth fall out.

Because of the general slope of the land the longest rivers flow towards the south, south-west and north. Except in the desert regions, the rivers are large and rapid, fed by the heavy precipitation and by the summer melting of the glaciers; from the latter comes a burden of "rock flour", derived from tuffs and breccias, which gives great erosive power to the rivers. In the desert areas, frequently formed in tuff districts, the water soaks into the porous ash or lava and later

flows out as clear springs from the base of the lava sheet. Though these rivers of Iceland have a great volume during the warm days of summer, they are useless for navigation on account of the irregular run-off. They lack large lakes to regulate the flow, whilst the swiftness of the currents and the dropping of the silt on the lowlands results in an ever-changing pattern of channels across the sandy wastes where vegetation refuses to grow owing to the icy-cold water. Unfortunately these wide rivers need expensive bridging and so they impede the provision of roads suitable for motor transport. Waterfalls are very common where the rivers run across the edges of massive basalt flows but the falls move rapidly upstream as the weaker underlying strata are undercut. Down the flanks of the fjords numerous small streams cascade over the narrow ledges of the individual basalt outcrops.

The coast line of Iceland, some 3,728 miles (6,000 km.) long, is much indented except in the south-west. The coast varies from the large bay and fjord type, found on the west, north and east, to the smooth sandy coast of the south. As in Norway, the fjords are bounded by high cliffs which, besides reducing the possibilities of settlement, greatly detract from their value as entrances to the country. Along the south coast occurs a long reach of sandy coast which is backed by shallow lagoons and the outwash fans from the high ice-clad country behind. This coast, the nearest to the main trading routes, is an unfriendly one even to modern craft, as it is difficult to distinguish in thick weather and, in places, dangerous currents set on-shore. From Ingólfshöfði to Dýrhólæy (Portland) the fluvio-glacial sand is so fine that, driven by the wind, it obscures the sea-edge in a yellow mist. "The east friths were first settled of all Iceland, but between Hornafjörður and Reykjanes was last completely settled, for the wind and the surf prevented the landing of men by reason of the lack of havens and want of harbours. Some of them that first came out dwelt nearest to the fells and marked the quality of the land there, because the livestock would always be trying to get from the foreshore to the fells."[1] Along this dangerous low-lying coast, incompletely protected by lighthouses, there have been many wrecks. To aid the succouring of shipwrecked mariners upright posts, about a kilometre apart, are driven into the uninhabited sandbars: these posts bear directions guiding them to the nearest refuge hut which contains provisions, clothing and maps. It is interesting to note that, owing to the absence of harbours and of knowledge of this south coast, it is always shown as greatly shortened on early maps of the country.

[1] *Landnáma-Bóc*, V, 1, 1.

CLIMATE

The position of Iceland between the North Atlantic and Greenland Sea results in a strong maritime influence on the climate. Warm water flows along the south and west coasts and cold water along the north and east; the temperature difference between the two is about 5·4°F. (3°C.) in summer and 9°F. (5°C.) in winter. Although the northern waters are cold they do not bring drift ice and fog to the northern coast every year; in severe years, such as 1888, however, ice drifts along the east coast and then westwards to the Vestmannæyjar where it can choke the harbour at Heimæy. The most severe ice year was 1695, when drift-ice closed the whole coast-line except at Snæfellsnes. These polar currents bear also great quantities of larch and pine driftwood from Siberia while occasionally the Gulf Drift brings to the southern and western shores of Iceland mahogany and sugar cane. Owing to the maritime influence Iceland is mild in winter and cool in summer compared with the mean for its latitude, but even so the frost-free period is short and on the higher ground snow lies for at least six months in the year; in short the climate seems raw and cold. The average centre of the Icelandic low-pressure system, which prevails throughout the year, is over north-east Iceland. In spite of the appearance of this low pressure centre on maps of average conditions, there is in actual fact a rapid variation of pressure, due to the succession of depressions, with different air-masses, which cross the island, particularly in the winter months: as a result the winds and weather are remarkably changeable. Winds tend to be strong, and during the fishing season gales have taken a great toll of human life: from 1850 to 1877 over 2,000 persons were drowned and of these three out of five in the month of March.[1] The size and relief of the island are sufficient to give orographic precipitation, a greater temperature range in the interior with warmer summers and colder winters than near the coasts, and also to produce warm, dry föhn winds on the leeward side. The account of the first settlement of Iceland suggests that at least one of the settlers noticed this warm föhn wind: "Bárðr . . . came in his ship to the north of Skiálfanda fliótz-ós and took in settlement all Bárðardal. . . . Now he marked that the land winds were warmer than the sea winds, and thereby thought that there must be a better choice of land to the south of the heath."[2] Everywhere the air is moist but the highest precipitation is about four times that of the north and occurs in the south-east, so helping to keep Vatnajökull

[1] Before children are allowed to leave school all, except the physically unfit, have to be able to swim. This regulation was made in an attempt to reduce the toll of life by drowning.

[2] *Landnáma-Bóc*, III, 17, 1.

in existence. The maximum fall is in autumn. The high latitude means that in the most northerly districts the sun is above the horizon for a week in summer and even so far south as Reykjavik the longest day is 20 hours 56 minutes, which greatly helps plant-growth; on the other hand, the shortest day is only 3 hours 58 minutes.

SOILS AND VEGETATION

Over the whole of Iceland the main component of the soil comes from the decomposition of basic igneous rocks which are of remarkably uniform chemical composition; this means that the soils have considerable iron oxide and phosphate content but a deficiency of calcium carbonate for the lime can only be separated with difficulty from its siliceous compounds. These soils have little coherence and great permeability. In the most densely settled districts the material below the subsoil generally consists of glacial and alluvial deposits which are often associated with *móhella*, volcanic ashes and lava-gravel. At the close of the glacial period were laid down clays, as much as 100 ft. (30 m.) thick, which are tough and dense and usually have under 0·2 per cent lime content which compares unfavourably with the 5–15 per cent in the Yoldia clays of Denmark. Iceland lacks a continuous vegetation cover and two-thirds of the land area has such a severe climate that it can be classed as desert, with vegetation existing only around oases. The flora is characterised by having only one-sixth of the number of species found in Britain and this is due to the uniformity of the soils and climate as well as to the isolation of the country.[1] The vegetation seems to be largely controlled by the winter conditions of snow cover, although the thicker soils found on the readily decomposed tuffs carry a heavier vegetation than do the basalt areas. One of the most extensive types is *mýri* vegetation which occurs where there is standing water; growing comparatively tall, with cotton grass, sedges and rushes it appears luxuriant compared with the other sparser types. Forests occur but these are low growing and consist of dwarf willows, birches and mountain ash. When the first settlers entered the country, the forest cover was more extensive, except in the outer fjord districts where climatic conditions were always too severe, and we read: "He [Steinolfr enn Lágе] walked inland [from Steinolfshialla in Fagadale], then up on to a mountain, and saw inland there a great dale all grown with wood. He could perceive one clearing in the dale: and there he built him a homestead, and called it Saurbœ: for it was very swampy, and he called the whole dale by that name. It is

[1] It is unknown how many species have been immigrants since the colonisation but the number now naturalised must be considerable.

now called Torfnes where the homestead was made."[1] Again "Above Klif it is called Kiarradalr, because there was brushwood and small shaws between Kiarrár and Þverár, so that it could not be dwelt in. Blund-Cetil was a very wealthy man: he had the wood cleared far and wide, and took up his abode there."[2] The burning of the forest to clear the land for agriculture was the custom in eastern Scandinavia and was practised until about 1150 in Iceland, suggesting a stream of eastern settlers in the occupation: thirty-one farm names contain name elements indicating burning for clearance.[3] Besides clearance of the woods for the sake of the land, the timber was used for bog-iron smelting, household fuel and general purposes.[4] Some of the timber was of sufficiently large dimensions to allow a ship to be built.[5] Elimination of the original woods was aided by the stripping of leaves for winter fodder and by casual grazing in unenclosed land. During periods of heavy snow sheep destroy trees by gnawing at the bark. The loss of birch copses upon the mountain sides increased the number and effect of snow and stone avalanches and turned them into naked and gravelly slopes with little or no soil or plant-growth. In some districts, soil-flows due to saturation from melting snows form mud-streams above the frozen subsoil, whilst elsewhere earthquakes have thrown from the hillsides soils which previously had supported coppices. To allow the birchwoods to regenerate in suitable areas it has proved sufficient to fence them off from livestock, while in recent years Norway pine and Alaska spruce have been planted successfully under the shelter of birches.

SETTLEMENT

Iceland is the only country in Europe for which detailed written records exist of the first considerable settlement.[6] For at least a hundred years before the Scandinavian colonisation Irish monks lived at places such as Papey but these priests, if true to their vows of simply seeking isolation to worship, would not affect the future settlement pattern. The Scandinavians migrating westwards from 874 A.D. onwards, to escape the overlordship of Harald Haarfager,

[1] *Landnáma-Bóc*, II, 18, 1.
[2] *Landnáma-Bóc*, II, 2, 2.
[3] S. Thorarinsson, 1944.
[4] "As Ondótz was cutting wood in the shaw for brewing a little before Yule." (*Landnáma-Bóc*, III, 15, 2.)
[5] *Landnáma-Bóc*, I, 7, 1.
[6] The Book of the Settlement, *Landnáma-Bóc*, is a unique systematic listing of 400 colonists and their dependants and gives, in conjunction with the later sagas, a magnificent glimpse of the manner of pioneer settlement over a thousand years ago.

FIG. 123.—SURFACE FEATURES OF SOUTH-WEST ICELAND.

The large area of lava in the west was the result of outpouring in historic times and so the appearance would have been very different at the time of the settlement.

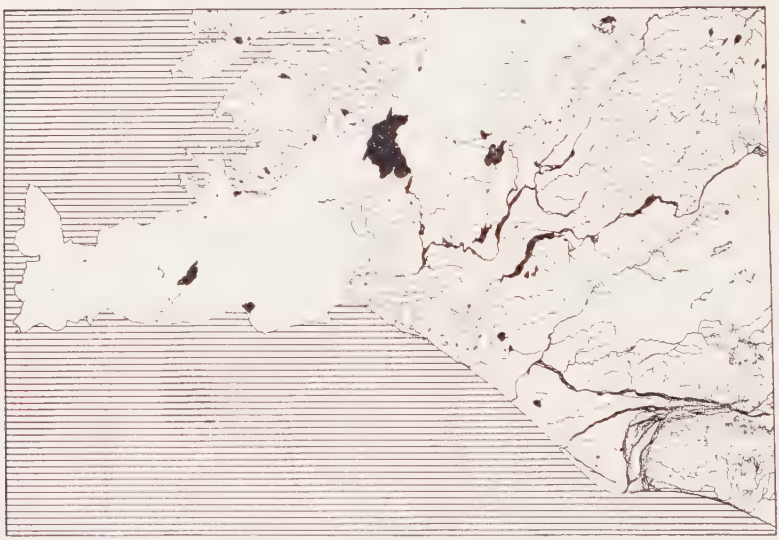


FIG. 124.—DRAINAGE.

The absence of surface water in the lava districts adds to the difficulties of settlement.

FIG. 125.—SETTLEMENT ACCORDING TO THE LANDNÁMA-BÓC

In so far as it is possible the places occupied are located; ? means a doubtful identification. The areas of known Irish settlers are stippled. 1. Prondr Miok-Siglande. 2. Sigvatr enn Rauðe. 3. Hrafn enn Heimske.

FIG. 126.—MODERN SETTLEMENTS.

Individual settlements are indicated by dots but towns such as Reykjavík and Hafnafjörður fail to show except as a cluster of dots. In the south-east of Figs. 123–126 the same area for icefields is shown although these would have been of different extent at the time of the settlement. These four figures are based on the 1:250,000 map of Iceland as published at København.

who was then consolidating his kingdom, settled in Iceland. Many had been concerned in viking raids and brought into the island their wives and thralls who were often Celtic; thus from the start there was an admixture of Scandinavian and Celtic stock. On the west in the Hvítá valley of Borgarfiorður there was a concentration of people of Irish blood and this later became a centre of outlaws. From the list of colonists it appears that most were of Norwegian origin but that about 12 per cent came in from the British Isles, although some of these also must originally have come from Norway. The colonists quickly occupied the country: "Men of knowledge say that the country was wholly settled and taken up in sixty winters, so that it hath never after been settled any more."[1] Not all the settlements were able to continue, for some were destroyed by floods and lava flows: e.g. "And that place [on the east coast] was thickly settled before the earth-fire ran down over it."[2] After occupying Iceland the settlers turned to distant trading voyages and are known to have reached the Black Sea from whence they brought a Mediterranean stock—as slaves—into the island. To-day, although of mixed origin, the Icelanders retain a speech without regional dialects and a pure Icelandic culture of which they are very proud and which they endeavour to maintain by rejecting, for example, words of foreign origin.

The early settlers built large "halls" and from these tended their crops, looked after their livestock, fished, did fowling and went on expeditions. The walls and roofs of the halls were made of turf[3] supported by roof trees which were brought from Norway. The farms generally faced south and comprised building clusters, including dwelling house, byre, hay-barns, storehouses and sometimes a forge. As early as 930 the first Alþingi, or general moot, was held and at this, the mother of parliaments, laws were made and judgements passed. All freemen could attend the Alþingi but only the chiefs had real power. This republic came to an end in 1262, after which year allegiance was paid to the Crown of Norway, and after 1381 to the Danish King. The first constitution was granted in 1874, Home Rule in 1904, and in 1918 Iceland was established as a sovereign state united with Denmark under a common king. In 1944, largely as a result of wartime rupture of communications with Denmark, Iceland became an independent republic.

It is estimated that the population in 930 was 40,000 and, after

[1] *Landnáma-Bóc*, V, 17, 3, written *c.* 1130.

[2] *Landnáma-Bóc*, IV, 17, 2.

[3] It is found with the greater humidity in the south than in the north that the houses with turf walls must be rebuilt more often as the moisture saturates and disintegrates structures.

nine centuries of distress due to civil and ecclesiastical strife, to famine, to plague and to the constraining of trade by the Danish Trade Monopoly which lasted from 1602 until 1854, the numbers had not appreciably increased. During the millennium following the colonisation there was little immigration, and until about 1880, little emigration, but by 1920 it was calculated that there were living in North America, the principal direction of emigration, 25,000 persons born in Iceland or of Icelandic descent. The severe climatic conditions helped to prevent the population from increasing very rapidly. "There was [976] a great winter of dearth in Iceland. . . . That has been the greatest [famine] in Iceland. Then men ate ravens and foxes, and many bad uneatable things were eaten; and some had the aged and helpless slain and cast over cliffs. Thus many men starved to death, and some lay out stealing and were therefore outlawed and slain. . . . Eighty winters later [1056] there was another dearth. . . . Everything was eaten then that the tooth could bite on. . . . There was at the time so much snow everywhere that most men walked to the All-moot [middle of June, 1057], but when the vow was made, immediately the weather bettered, and it became the finest summer; and the winter after was so good that there came no frost in the earth."[1] These famines, whether caused by weather or vulcanicity, were severe enough, but their effect was less than that of the plagues, for between 1402–5 it is estimated that one-third to one-half of the population died from the Black Plague.

These centuries of disaster left their mark and towards the end of the nineteenth century there was a feeling of apathy and regression in the use of this country which was cut off from the outer world for the half-year from October to March. To-day there has been a revival of activity and the population is increasing at a rate which would double the numbers in seventy-five years.

Iceland is the most sparsely peopled of European countries; even if the density of population be calculated on improved land, the figure is only 777 persons per 100 sq. miles—i.e. 3 per sq. km. The rural units were large pastoral holdings, carrying a small number of livestock per unit area, and this necessitated scattered dwellings. Not until the growth of the modern fishing industry could the nucleated settlement develop; indeed without such settlements along the coast the catch could not be handled. Even more than in the case of København in Denmark, the capital city has acquired an abnormal proportion of the population and there is no other effective centre to balance the pull of Reykjavík. There are numerous small townships, which contain, in the aggregate, a considerable proportion

[1] Mantissa 3. 1–2 in *Origines Islandicæ* translation.

of the population, for in the last forty years there has been a steady drift to the towns. By 1926 four of these fishing centres—Akureyri, Kaupstaður (Vestmannaeyjar), Hafnafjörður and Ísafjörður—each contained a greater population than were in Reykjavík in 1872. By 1945 Siglufjörður and Akranes had also exceeded this population (i.e. 1,800). The towns have progressively increased their proportion of Icelandic population: 1880 5 per cent, 1900 12·9 per cent, 1920 30·7 per cent and 1957 70 per cent. Ironically this rural depopulation has accompanied the provision of roads and telephones and of regular contact with the outer world: parallels can be found to this depopulation in the highland districts of Scotland as well as in Scandinavia. Lowlands aggregate but one-fifteenth of the area of the country and extensive lowland areas occur only in south and west Iceland, and it is these districts, together with the valleys of the narrower coastal lowlands, which permit permanent habitations and the rearing of cattle; the few inhabitants dwelling on the lower parts of the plateau are almost entirely dependent upon sheep-rearing. But not all the lowlands are grass-covered for many cannot support plant-life on their lava, gravel or blown sand surfaces. To the south of Vatnajökull the people dwell on the flanks of the grassy slopes and avoid the lowlands which are swept over by fluvio-glacial waters. Unfortunately the largest and most fertile lowland in Iceland, lying between Reykjanes and Eyjafjallajökull, is open to the blowing of ashes and fumes from Hekla, and of sand and pumice dust from the interior plateau with northerly winds. In several districts in the lowlands ice-scarred ridges (*holt*) protrude through the morasses and grassland and besides giving a characteristic appearance to the landscape have been used for farm sites.

FARMING

The change of emphasis in occupation is of interest in that it offers certain analogies with the Færoes, although the concentration upon the fisheries has not gone so far.

Iceland: Percentage of Population by Occupations

	1880	*1940*	*1950*
Agriculture	73·2	31·6	19·9
Fisheries	12·0	16·3	10·8
Industries	2·1	21·9	32·5
Transport and Commerce .	3·6	17·3	17·9

[Based on Th. Thorsteinsson, p. 22, and "Norden", Table 10.4]

Not merely has the proportion of those engaged in agriculture decreased from over two-thirds to under one-fifth but the absolute number has also declined by nearly 25,000 persons.

After over a millennium of occupation Iceland has only two-fifths of its area occupied and of this fraction only 386 sq. miles (1,000 sq. km.), that is under one per cent of the whole area, is cultivated or enclosed for reclamation as birch forest. The rest can be described as rough grazing. There are references in early documents to cereal growing in Iceland and from pollen preserved among the volcanic ashes it is known that barley and oats were grown in Þjórsárdalur before Hekla's eruption in 1104.[1] Grain growing diminished, despite many attempts at cultivation from the seventeenth century onwards: the first country-wide success was in the 1930s and this may be due to the favourable climatic conditions then prevailing over the North Atlantic area. The average frost-free growing period may not seem short, as shown for representative lowland stations in the table below for the years 1873–1906, but the situation is worse than the statistics suggest for even in the most favoured sites the only month free of frost liability is July. Many of the days which do not have frost fail to achieve warmth enough for effective plant growth, that is more than about 43°F. (6°C.).

Frost-Free Days at Coastal Sites

Location	*Number of days*
Stykkisholm	199
Vestmannaeyjar	256
Berufjord	207
Grímsey	173

To-day the farms are still essentially large isolated pastoral units, averaging 1,360 acres (550 ha.), based on hay collection. As in similar regions of northern Europe there is a small enclosure of improved land (*tún*), averaging only 16 acres (6½ ha.) and located conveniently near to the house. The farms are built on the lowlands above the floodable limit but away from the scree slopes to avoid damage from falling stones. Potatoes and turnips are the main crops but even so there have to be considerable imports of the former. Since 1923 the use of the hot-springs for heating greenhouses has extended the types of fruit and vegetables which can be

[1] The farmhouse at Stöng has been excavated and with its excellent exposure of a mediæval settlement has been called the Pompeii of Iceland.

cropped, and tomatoes, early potatoes and other crops, including the exotic grape, now figure in the list of products. It has been found that the potato yield is doubled by heating the ground with pipes from hot springs: the growing period is lengthened and protection is given against damage from summer frosts. Hay-making still remains the basis of the economy to tide the livestock over the winter and the gathering of this hay, even if from a fenced field fertilised with nitrates and phosphates, and the drying of it form the most arduous part of the rural life. The Hvítá watercourse, in the south-west, has been used since 1931 and the Thjórsá since 1923 to irrigate, and fertilise by "warping", the hay meadows but most of the rivers, liable to change of course and chilled as they come from glaciers, cannot be so used. It has been claimed that the Thjórsá and Hvítá valleys could, by the adoption of intensive dairying, support tens of thousands more people than they do at present. Hay from the boggy stretches is used especially as winter fodder for horses and sheep: only the best part of it is fed to the cows which are mainly fed upon hay from the infields. During the hay-making period, which lasts from July to September, the pressure on the labour supply is great and it is unfortunate that this period of demand should coincide with the maximum need for shore work in connection with the herring fishery. It is during this period too that the livestock have to be moved to the higher grazings where the young grass is then growing: it is estimated that there are some 2,317 sq. miles (6,000 sq. km.) of these summer grazings.

Despite the drift of population away from the land agricultural output has increased in the past half century as a result of improvements in land drainage and in the techniques of farming. The improvements have been facilitated by the provisions of the Improvement of Estates Act of 1923 and by the adoption of co-operative purchasing and selling which have brought more aids within the reach of the farmer's pocket. Unfortunately the numerous hummocks formed by frost-heaving limit the adoption of machinery which is so badly needed in a country short of man-power.

Since early times Iceland has based her economy upon sheep but it has proved an uncertain foundation, for the numbers of sheep are always greatly reduced after severe winters or poor summers for hay-making or by disease. In order to conserve the home pastures for hay the sheep are sent to the plateau grazings, where they remain unattended from the end of June until the middle of September. Great numbers perish by falling into clefts, by sudden snow-storms, by drowning, by the depredations of wild foxes and by starvation in these desolate districts. Many of the farms dependent upon these upper grazings are abandoned in years of cold, damp summers but

are reoccupied when favourable years return. Nevertheless Iceland with 4½ sheep per head of population in 1958, had a greater number of sheep in relation to the population than any other European country; Bulgaria with 1 was second. The production of mutton is greater than home demands and meat is exported as well as wool and green-salted sheepskins. There used to be a woollen textile manufacture for wadmal, a coarse woollen cloth, figures in old lists of exports and there is mention in the sagas of the collection of dyeweeds. The difficulty of winter fodder supply prevents the creation of a cattle industry as great as would be justified by the summer pastures. Owing to the use of horses for transport the number of these per capita is the highest in Europe: formerly they were exported to the British coalfields but the main market for these small animals is now in Denmark where draught animals are needed on small holdings. Stimulated by the success of Canadian and Norwegian enterprise, silver fox farming was tried from 1930 using wild birds for food. Fowling on the cliffs has not been such a great feature as in the Færoes but for centuries the eider-duck has provided a source of income for the collecting of down and fear has been expressed that the eider-down industry may be greatly reduced if the silver-fox farmers use the eider-duck for feeding purposes. Mink are no longer reared as feral mink damage the eider industry.

MINERALS

The reserves of minerals are so limited that there cannot be any considerable industry based upon them. Sulphur has been worked in the volcanic districts, particularly in that around Mývatn, and there are records of its export from the port of Húsavík from the thirteenth to the nineteenth centuries. Iceland spar was worked from 1850 to 1914 near Reyðarfjörður, in east Iceland, for optical instrument manufacture, but the deposits of material suitable for this purpose are now exhausted. Lignite has been worked spasmodically but the quality is so poor that it would not be mined except for the shortage of alternative indigenous fuels other than peat. Bog-iron was worked from the early days of the colonisation: "He dwelt at Dalsminne. He was the first man to forge iron-ore in Iceland, and therefore he was called Rauda-Biorn (Red-ore Beorn)."[1] From Egils Saga we glean: "He was a great iron smith, and used much red iron ore during the winter." In the west and also to the east of Akureyri are many remains of scoriæ and also traces of simple furnace-pits. Salt was required for preserving fish and flesh and there must have been some production of this in Iceland for

[1] *Landnáma-Bóc*, II, 4, 1.

we read—"Hallsteinn had harried in Scotland, and there he took the thralls which he brought out to Iceland. He sent them to salt-working in Svefn-eyjar."[1]

INDUSTRIES

Such effective industry as has developed in Iceland comes from the productive sea fisheries and the fish treatment plants which exist around all the coasts except on the inhospitable, almost harbourless, south shore. The future may be more productive, for although Iceland possesses a number of hydro-electric stations (the largest of which is on the river Sog at Neðri Fossar) the potential power supply has scarcely been touched. With a very limited manpower and a strong repugnance to immigrant labour, the most likely industries to develop using the abundant water-power are the fixation of atmospheric nitrogen and the extraction of aluminium from the native bauxite deposits. Another asset is the abundant hot spring flow and the capital now has many of its buildings heated from this supply. This source of heat may be used to develop industries beyond the present limited application to market gardening. Much of the present industrial development is a result of restricted imports during the economic depression of the early 1930s leading to attempts to foster production within the country.

FISHERIES

Sea fishing is one of the principal industries of Iceland for rich grounds extend all round the island; the northern and eastern coasts have Arctic conditions and the southern and western Atlantic. The catch consists principally of cod, coalfish, haddock and herring. The fishing boats immediately before the introduction of modern decked types were close lineal descendants of those used in saga times, with the fish caught by hand lines and long lines. While such lines continued to be used after the introduction of the decked vessels, the fishing changed in character for more distant grounds could be reached. The second, and greater, change was the introduction in 1904 of power-driven craft with trawls for cod and haddock and seine-nets for herring. The change in the character of the Icelandic fishing fleet is summarised in the table opposite.

The Icelandic Government has endeavoured by loans and education to improve the technical equipment of the fisherman and this has been reflected in the change from traditional types of craft to modern vessels. The resulting huge hauls required efficient shore-bases to

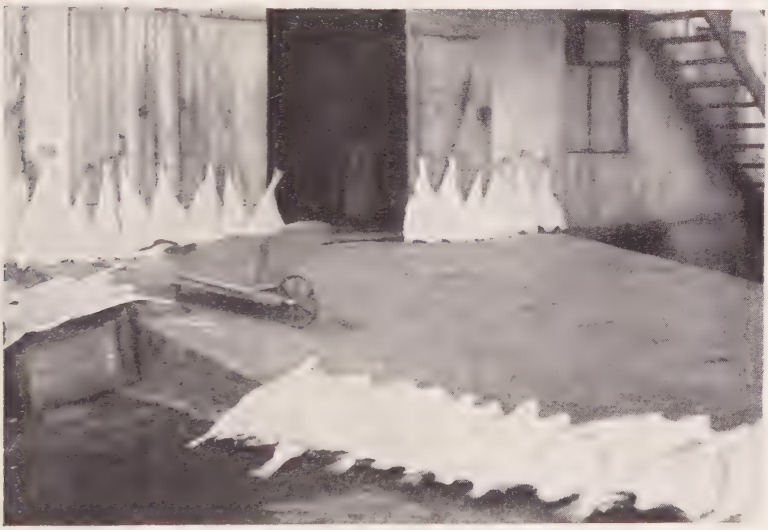
[1] *Landnáma-Bóc*, II, 20, 1.

Icelandic Fishing Fleet, Numbers of Craft

	1905	*1915*	*1925*	*1935*	*1945*	*1960*
Sailing vessels	165	95	11	0	0	0
Motor boats, over 12 tons		40	201	277	360	563
Trawlers, etc.	4	26	74	60	39	65
Motor boats, under 12 tons	1,944	391	394	665	345	140
Rowing boats		1,121	811	117	26	0

(Based on Thorsteinsson, 1946, p. 108, and Viðskiptaskráinn, 1961, p. 655)

handle the catch and these were created alongside the fjords adjacent to the fishing grounds. By quickening the flow along the arteries of communications, these changes in the character of the fishing industry stimulated life in the country as a whole. Since 1920



A.C.O.] [*August, 1938*

FIG. 127.—DRIED COD OUTSIDE WAREHOUSE AT VESTMANNAEYAR.

artificial curing has supplemented drying in the open air. The traditional production of *stockfisk* is no longer the chief way of preserving the cod catch and now modern technique produces an article more suited to present-day tastes: canneries were established in the boom period following World War I but all subsequently failed. There has been a big increase in the export of frozen filleted fish: the average export 1931–4 was 283 tons, which had risen to

67,900 tons in 1959. Besides the portion of the catch landed in Iceland some of the catch, taken from the prolific grounds by British and other foreign vessels as well as by Icelandic craft, is landed direct at ports near the consuming centres of Northern Europe. A valuable source of income is the production of red-fish and cod-liver oils for the sake of their vitamin value, while herring oil is extracted for the manufacture of margarine and soap, with fish-meal for livestock feeding as a by-product. During some of the war years 1939–45 Icelandic vessels supplied Britain with great quantities of fish and the high prices then received have enabled new vessels of

A.C.O.] [*August, 1938*

FIG. 128.—VOLCANIC CONE AND HARBOUR AT VESTMANNAEYAR.

the latest large-trawler design to be purchased from British ship-builders, whilst the older vessels, bought second-hand from Britain, were sold either to the Færoese or as scrap. Since the war the herring shoals have not been so abundant, for the two months from the middle of July, in Icelandic waters, and this has increased the economic problems of the island. An associated industry is whaling; after a period of over-catching the whales were protected until 1935 when the Norwegians started a new shore station.

The fishing centres are frequently established on spits projecting into the fjords with the jetties on the more sheltered landward side. On these constricted sites the towns tend to be compact and so contrast with the ribbon development elsewhere. Of the fishing centres that of Heimæy in the Vestmannaeyjar group offers interest.

The inlet on which it stands is near valuable cod fishing grounds and this led to its utilisation, even though—unlike most of the Icelandic townships—water is here in short supply and the rain has to be collected from the house roofs.

COMMERCE AND TRANSPORT

Trade with Iceland has through the centuries been based on the few staples the country could produce. Up to the end of the thirteenth century wadmal (a woven wool) was the chief item of export. For several generations after 1262 Icelandic trade was limited, by law, to traffic with Bergen and the Norwegians encouraged the export of fish, wadmal and hides, but in the second half of the fourteenth century the merchants of the Hanseatic League destroyed this traffic in order to foster their other trading connections. This encouraged English merchants to come for stockfish and to sell commodities such as food, linen and hardware. Not all the English visitors were welcome, for some plundered the coastal lands. The Hanseatic merchants later reversed their policy and ousted the English traders, encouraging the export of wadmal, train-oil, hides and sulphur. The sixteenth and seventeenth centuries saw the recrudescence of activity among pirates who destroyed the coastal farms, and before trade could properly recover it came, in 1602, under the stagnating control of the Danish Trade Monopoly which for two and a half centuries prevented any real use of the resources of the country and kept Iceland in a backward state, without greatly profiting the Danish merchants, who had to pay the King 16,000 kroner for the privileges they enjoyed. During the four years from 1782–5 Iceland lost over one-fifth of her population by famine and, with the bankruptcy of the Danish merchants holding concessions as the Iceland Company in the Monopoly Trade, ordinances were passed which reduced some of the monopolistic controls in an endeavour to alleviate the misery of the country. Since the complete freeing of trade in 1855 there has been a remarkable surge of new activity in the country and while the population has increased by fifty per cent the number of business concerns rose from 58 in 1855 (32 of which were owned by Danes outwith Iceland) to 1,331 in 1944, all of which were run from Iceland.

In 1872 the only connection with the outside world was a single steamer which arrived from Denmark six times a year: now there are Icelandic and Danish steamers, each calling every three weeks, a Norwegian service arriving nine times a year, while coastal vessels constantly work round the island except when prevented by weather or ice conditions. The introduction of regular air services has

brought Iceland into more intimate connection with other countries of the North Atlantic fringe whilst since 1938 regular internal air routes have revolutionised transport conditions.

The present century has seen many changes which augur well for the future: the Bank of Iceland was founded in 1902, the first internal telegraph lines were supplied to connect with the submarine cable to the Færoes and Shetland Islands in 1906, and the University of Reykjavík was founded in 1911, the same year as the publication of the first successful daily paper. In 1890 there were only bridle tracks in the country but by 1945 there were 2,750 miles (4,400 km.)

FIG. 129.—MODERN SUBURBS AT REYKJAVÍK.

House building, of cast concrete with galvanised roofing, is proceeding apace with many of the future occupiers working in their spare time. The houses, of varied design and bright colours, have changed the post-war appearance of the capital.

of "high" roads, and much money is being spent on the construction of bridges to span the strongly flowing rivers. In 1927 there was a proposal for a railway from Reykjavík to the rich, agricultural Hvítá and Thjórsá valleys: this was to be constructed by a Norwegian company in return for the right to develop a water-power site but the concession was allowed to lapse, and Iceland has by-passed the railway age.

With the improvement of roads and transport the farmers have lost their self-sufficiency, a feature reflected in the more varied imports of the country. The exports remain the staples of fish and fish products, the products of sheep farming, live horses and a

limited quantity of dairy produce. Spain and Italy have been the principal importers of salted fish, and, because of the need to sell this product, relaxation of a virtual prohibition of imports had to be

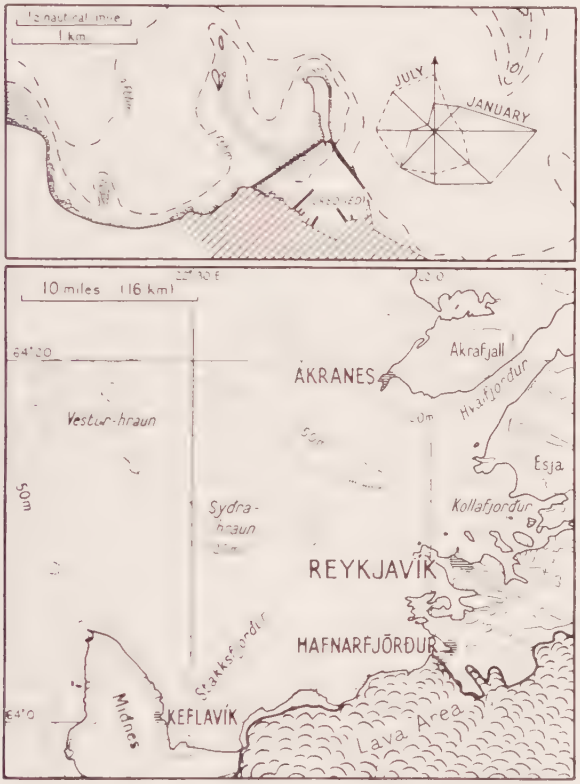


FIG. 130.—SITE OF REYKJAVÍK.

The capital is situated to the north of a lava field but has warm springs within the city limits. Most of the warm water for central heating is drawn from more liberal supplies to the east. The town of Hafnarfjörður was founded by an English fishing company at a site convenient for the fishing banks and for drying the cod but, owing to the rough lava surface, very difficult for house building. The harbour at Reykjavík has needed long breakwaters to protect it from north-westerly winds (as experienced in July) and easterlies (in January).

Based on maps in *Islands Kortlægniog*, København, 1944 and wind directions from Admiralty Sailing Directions.

allowed in favour of Spanish wines. Under the stress of inter-war economic troubles Iceland adopted a rigid control of imports and of currency in an endeavour to avoid national bankruptcy. During the Second World War, when Scandinavian connections were

severed, Iceland turned to trade with the U.S.A. and imports from there rose from the 1·2 per cent in 1938 to 66·7 per cent in 1944: since the war, however, the previous trade connections have been partly resumed. The impressive scenery and clear northern skies make it probable that the tourist industry may develop further and provide a valuable source of currency.

Most trade circulates through the capital, Reykjavík, which stands on a peninsula giving some natural shelter. The town is close to the more fertile coastal lowlands and is the best natural port site in the southern half of the island: that is, in the sector nearer the trade routes. The port works, of recent origin, are now considerable but with a spring tidal range of only 14½ ft. (4½ m.) wet docks are not required and open basins suffice. The increase of population as trade and activities have increased has converted the capital from a village of 1,800 souls in 1872 into a city with 71,037 inhabitants in 1959, two-fifths of the island's population. Owing to the relief of the interior one port cannot serve the whole community and so there are several other ports for trade and, of these, Akureyri, which serves the north, is the largest. Akureyri is situated beside a long protected fjord and its port enjoys the shelter of a sandspit, but unfortunately it is open to the material brought down by the Eyjafjardará and the silt of the delta foot is approaching the waterfront despite the construction of a protecting wall on the landward side.

CHAPTER 14

GREENLAND (GRØNLAND)

59° 46′–83° 40′ N.
10° 50′–73° 00′ W.

The southernmost point of Greenland, Cape Farewell (Kap Farvel) lies in the latitude of the Shetland Islands and its northernmost points, Capes Morris Jessup and Bridgman, are only about 440 miles (700 km.) from the pole. Its area, now computed at 840,000 sq. miles (2,176,000 sq. km.), is about that of the subcontinent of India but, owing to the nature of projections suitable for an atlas map of the world, this similarity is frequently concealed. For long a Crown Colony of Denmark (despite certain vigorous Norwegian efforts in this century) the total area is some sixty times that of the home territory but the population is numbered in tens of thousands instead of millions. By a new law of 1953 Greenland became part of Denmark with two representatives in the one House which is replacing the two-House Riksdag. This polar region has acquired a fresh significance in modern times both as an area suitable for meteorological forecasting to give advance information of the polar air-mass likely to affect Europe and as a region of strategic importance in the defence of the United States. This latter potentiality was first recognized by Peary but when the United States purchased the Virgin Islands from Denmark in 1916, all claims to land discovered by Peary were relinquished; however, a compromise arrangement was arrived at twenty-five years later to allow air-bases and meteorological stations to be established during the occupancy of Denmark by the Germans. In 1950 this arrangement was confirmed on a peacetime basis.

PHYSICAL FEATURES

Greenland can be regarded as an outlier of North America both on the basis of structure and of ethnography so that Denmark Strait forms the barrier between the Old and New Worlds. Structurally, Greenland consists of a plateau composed of Archæan rocks, with highly metamorphosed rocks of the Arsuk (Algonkian) formation occurring near Ivigtût. This ancient massif is overlain by Lower Palæozoic rocks, with American affinities in the fossils, Upper Palæozoic rocks and rocks of Jurassic and Cretaceous age. During

the Tertiary period, particularly in the early part, there was a violent outburst of volcanic activity resulting in the formation of basalt layers aggregating over 5,000 ft. (1,500 m.) in thickness. Interbedded coal and shale layers represent a vigorous plant growth when a warmer climate occurred in Eocene or Miocene times. Hot springs, a sign of declining volcanicity, occur in the Archæan area at Ũnartoq (104°F., 40°C.) and Liverpool island in Scoresby sound (140°F., 62°C.), and in the basalt areas of Disco fjord (50° to 60°F., 10° to 15°C., chilled by melting ice to about 35°F., 1·6°C. in summer), at Mellemfjord (64°F., 18°C.) and at Turner Land, south of Scoresbysund (100°F., 38°C.). Above the hot spring at Ũnartoq there hangs a fog bank due to the cooling of the moist, warm air above the spring.

With so little of the land free from ice, it is difficult to distinguish trend-lines, but the old sediments of northern Greenland, which were highly folded in the Devonian period, mark a continuation of the Caledonian fold zone of Spitsbergen, Norway and Scotland. As in Scandinavia proper there has been recent uplift, and marine terraces occur, up to 300 ft. (90 m.) above sea-level, containing shell species similar to those still living in Arctic waters. On the other hand mooring-rings in West Greenland now occur below the highwater mark while the foundations of the mediæval church at Saundries are well below high-water mark and there must have been a subsidence of at least 16½ ft. (5 m.). Thus the most recent movement of all has been of subsidence or of the land failing to rise as rapidly as the sea-level while the ice-caps were melting.

While the central area has a perpetual ice cover there is an ice-free coastal belt, the width of which may be very considerable, occasionally reaching 100 miles (160 km.); this belt is, however, crossed by tongues of glaciers. In West Greenland the ice-free area is estimated to be about 44,787 sq. miles (116,400 sq. km.); here the higher peaks generally rise only to about 5,000 ft. (1,500 m.) but the highest peak, 7,230 ft. (2,170 m.), is in the south, within 50 miles (80 km.) of Cape Farewell. The clear air and the steep rise from the coast make these peaks appear loftier than they actually are. In east Greenland the mountains are higher than in the west: Gunnbjoras Fjæld, north of Angmagssalik, now believed to have a height of 12,140 ft. (3,700 m.), is the highest mountain in Greenland. In the north the land free of ice is a rough terrain with peaks rising to over 6,500 ft. (1,950 m.).

The erosion of the fjords must have been accomplished since the spread of the Eocene-Miocene basalt sheets and this stupendous erosion in a short time (geologically speaking) has been aided by jointing and by earth movements leading to faults along which erosion was facilitated. The innumerable, rapid streams are still

vigorously cutting down, while the valleys were opened out during the former more widespread encroachment of the inland ice. Not all the action has been erosive for Roussell gives clear evidence from the Norse site at Imegarpog that the Ameragdla, a river in the West Settlement area, must have silted-up at the rate of at least 0·4 in. (1 cm.) a year.[1] Above the inland ice rise peaks, sharpened by frost action, of the type universally known by their Eskimo name, nunatak.[2]

CLIMATE

The climate of Greenland is becoming better known with scientific interest in the region and it has been found that there are considerable deviations from the means, particularly in the months of January and February. At Upernavik, for example, the maximum temperature recorded in February has been 60·8°F. (16°C.) and the minimum −44·1°F. (−42·5°C.); incidentally this is the lowest recorded reading anywhere in the coastal zone of Greenland. For some years now the Danes have recorded meteorological observations at Eskimonæs in eastern Greenland and the Norwegians at Myggbuckta, but during the war there was a rapid expansion of stations, despite the difficulties of bringing in supplies, and at the end of the war about twenty meteorological stations were taken over from the United States by the Danes.

In the north of Greenland there are eight months below freezing-point but the southern coastal zone is intermediate between the relative mildness of north-western Europe and the eastern margin cold of Labrador. This is in part a result, particularly in summer, of some maritime moderating influence.[3] Hartstene bay, near Thule, for example, has a more moderate climate because the Arctic current is deflected so that the water remains more open in winter. The frost-free period may be very short: at Ivigtût it is 158 days but at Upernavik it is only 70 days. Owing to föhn wind action, however, the temperature of the warmer days does not vary with the latitude.

It used to be believed that there was a permanent anticyclone over Greenland causing outblowing winds, but observations made on the inland ice during the inter-war years show that this view was incorrect.

[1] A. Roussell, *Farms and Churches in the mediæval Norse Settlements of Greenland*, København, 1941, p. 15.

[2] In the North of Greenland also called *pingos*.

[3] The 1948–50 Danish Expedition to Pearyland found that the summer temperatures were higher than those in North-East Greenland and that the fjord ice broke earlier. It was also found that the number of hours of sunshine from April 9th to September 5th was greater than that in Denmark for the whole year.

During the Wegener Expedition it was discovered from captive balloon observations that a temperature inversion of 15–20°F. (8–11°C.) existed at about 1,000 ft. (300 m.) above the ice surface. This cold surface layer of air is believed to be due to reflection of solar radiation by the snow; the loose snow of the surface is a poor conductor for transmitting heat, while the clear skies facilitate upward radiation. These factors permit the development of abnormally low temperatures in the air in contact with the snow surface. The surface of the inland ice has very gentle slopes on its surface, and this helps to maintain the inversion, but the steep outer edge encourages the air to pour off as a strong katabatic wind which is canalised by the fjord valleys. In its rapid descent the air is warmed and so has an effect on the lower lands similar to that of the föhn wind of the Alps or the chinook wind of the Rockies. Although it is warm it comes in violent gusts which can be dangerous when small craft have to pass across water at the foot of a steep coast. During the Watkins Expedition (1930–1) anemometer readings at Angmagssalik gave föhn wind speeds of over 129 m.p.h. (206 km.p.h.) and the gale which followed this blew for 13 hours at Force 12 on the Beaufort Scale. These föhn winds, which have been known to raise the temperature 50°F. (27°C.) can remove a snow cover as efficiently as the sun, while they raise great, towering clouds above the mountains. Winds formed of maritime air may flow in and reverse the katabatic effect. Another effect of the strong winds is the blowing of sand and dust on to the ice and the darker colour of this deposit leads, through greater absorption of the insolation, to the pitting of the ice-surface.

Precipitation on the coasts of Greenland decreases from an average of about 45 in. (114 cm.) in the south to under 10 in. (25 cm.) north of 69° N. It is probably this reduction in the precipitation which results in the thinner ice cover of the north. Most of the fall occurs in late summer and autumn while the winters are dry, except in the south. Snow can occur at any time of the year. Fog or mist is very frequent in July and August, especially on the edge of the sea-ice, and although not found in the inner fjords it handicaps access to settlements. As a result of the very unequal density layers in the lower atmosphere mirages are frequently seen. A drawback of the climate in the south-west, where the old settlements are located, is its encouragement of mosquitoes, amounting to a plague, during the warmth of July and August.

The climate must have ameliorated, as the ice-sheet was once of greater extent, but some mountain peaks are so sharp in profile that even then they must have been nunataks exposed to frost action. To-day the inland ice, swelling like a frozen sea but with not a sign

Temperature and precipitation at Greenland Stations.

Station	Latitude, N.		Mean annual Precipitation		Mean annual Temperature	
	°	′	in.	cm.	°F.	°C.
West Coast:						
Ivigtût	60	12	45	116	33	0·5
Godthaab	64	11	24	60	29	−1·6
Jacobshavn	69	13	9	23	22	−5·5
Godhavn	69	15	15	38	23	−5·0
Upernavik	72	47	9	23	17	−8·3
Thule	76	34	3	8	9	−12·7
East Coast:						
Angmagssalik	65	37	34	85	29	−1·6
Scoresbysund	70	29	12	30	17	−8·3
Myggbukta	73	29	3	8	13	−10·5
Danmarkshavn	76	46	6	16	9	−12·7

of life, has a thickness, according to the findings of the Wegener Expedition, of 3,000–6,000 ft. (915–1,830 m.), and it is said that the volume of ice, if melted, would raise the sea-level all over the world by nearly 20 ft. (6 m.). The southern part of the inland ice was first crossed by Nansen in 1888 and the northern by Peary in 1892, and further reconnaissance traverses and air surveys have shown that the area is less than had been believed, for along the east coast north of 66° N. there are broad rock outcrops.

The ice cover culminates in three domes; the northern one (71–72° N., 36–37° W.) is at least 10,150 ft. (3,100 m.) high and is joined by a saddle to the central dome (67° 30′ N., 37° W.) which is nearly 11,000 ft. high; this is separated by a col of 8,000 ft. (2,438 m.) from the southern dome (65° N.) which rises to 9,200 ft. (2,810 m.). From the domes, or foci of growth, there are gentle slopes until the edge is reached, but the fringing zone, sloping steeply, is deeply crevassed. The inland ice reaches the sea coast and presents an ice-cliff for nearly 200 miles (320 km.) near Cape York while large glaciers reach the coast elsewhere. The axis of the ice-cap, where accumulation is most in excess of ablation, is to the east of the arithmetical meridianal axis and the Wegener Expedition found at their observing station of *Eismitte* that the annual increment of firn represented 12½ in. (32 cm.) of water, while below about 4,500 ft. (1,370 m.) the ablation loss exceeded the annual increment of precipitation. Reduction of the ice volume takes place by the discharge of glaciers as well as by a limited melting. In Greenland occur the fastest known moving ice lobes, hence the term "running glaciers". The Upernavik glacier, for example, has been recorded

as flowing at 125 ft. (28 m.) per day. The speed is greatly reduced in winter and the northern glaciers are much slower than those of the south. The glacier pushing down the fjord valley may float—thus on Petermann fjord the lower 25 miles (40 km.) of the glacier is afloat—but this is exceptional farther south, where the tidal range and open sea of summer encourage the calving of icebergs which is accompanied by the generation of a wave, up to 60 ft. (18 m.) high. This wastage of the glaciers can be tremendous; it has been estimated that the Jacobshavn glacier sheds 1·4 cu. miles (5·8 cu. km.) of ice a year. The process goes on throughout the year but the icebergs penned up by sea pack-ice cannot leave the fjords until the summer, then as the winter ice weakens with melting the icebergs, often driven by strong föhn winds, shoot out of the fjords.

HISTORY OF OCCUPATION

Greenland was discovered to Europeans by Gunnbjörn, an Icelander, in the year 877 A.D. when he was driven by a storm from his course. In 983 Erik Raude (Eric the Red) was outlawed and he spent three years on the coast before returning to announce the discovery of Grønland which offered conditions suitable for settlement and the following year an expedition left to found the colonies of Østerbygd (East Settlement) and Vesterbygd (West Settlement). Contact was maintained not only with Iceland but also with Norway and, later, churches were built and linked with the Scandinavian ecclesiastical organisation. A runic stone, found just north of 72° N., shows that the Norse colonists went sealing along the west coast. Pollen analysis shows that the climate deteriorated and also that in the closing years of the settlements there were insect pests which destroyed the vegetation.

The late mediæval scholars lost all contact with, and knowledge of, Greenland and the land was first effectively rediscovered by Martin Frobisher in 1576 and again visited by John Davis in 1585 who named the territory "Land of Desolation."[1] Meanwhile there are extant documents showing some persistence of the older traditions. Ivar Bardsen, who was born in Greenland, wrote about 1349 sailing directions from Bergen and Iceland to Greenland and a somewhat garbled version of this was printed in *Purchas His Pilgrimes*. Bardsen refers to Gunnbjörn's Skerries, lying nearer Iceland than Greenland, as a mark on the voyage and a map by Ruysch in an edition of Ptolemy published in 1507 has a note against this site "Insula haec

[1] There had been during the previous hundred years sightings of Greenland, and indeed landings, by the Danes and Germans but reawakening of interest dates from the voyages of Davis and Hall.

anno Domini 1456 fuit totaliter combusta";[1] in Doncker's map of the area[2] there is a shoal marked and named Gunbar Scheer, a corrupted form of "Gunnbjörn's Skerries". However, very deep water is marked on modern charts for this area and this seems to prove that the information was faulty. Bardsen also reported the presence, in Greenland, of hot springs.

Ignorant of Bardsen's sailing direction a Venetian, Nicolò Zeno, sailed north and after sundry adventures in the Færoes, extending over several years, made a voyage of discovery in 1392 and arrived at Engromelant [Greenland]. Unfortunately his reports, and those of his brother Antonio, were largely destroyed but a descendant, Nicolò Zeno, in 1558 published an account with a map which, as the original "was rotten with age", had errors added by the younger Nicolò Zeno. There is no doubt that there had been some acquaintance with Greenland, though not so ancient as the descendant claimed, and a contact with the Norse, although it might have been secondhand and not personal. Zeno reported a monastery close to a volcanic hill and a hot spring which was used for heating the monastery and the church as well as for warming covered gardens in which fruit and herbs were grown, although frost lasted for nine months in the year. The warm springs prevented the fjord freezing and here congregated fish and sea-fowl which were caught by fishermen using boats made from "fish skins". The monks came from the Shetland Islands, Norway and Sweden. Although no volcano has been located and the hot springs do not rise now beside the monastery site nevertheless the account, despite serious errors or falsifications, would seem to be basically true. In the time of Erik Raude there had been expeditions farther west and they reported discovery of Hulland (Slate land, possibly Newfoundland), Markland (Wood Land, possibly Nova Scotia) and Vinland (Vineland, unlocated). Antonio Zeno was alleged to have visited "Estotilanda" and the description could apply to the southern states of the U.S.A. Unsatisfactory and confused as is the original, and suspect as is its authenticity, nevertheless this account emphasises how Greenland has a bridging value owing to its location between the old and new worlds.

After 1448 all regular contact with the homeland ceased and when Davis landed in 1585 near the site of Godthaab he found that the only people were Eskimoes. The voyages of James Hall in 1605 and 1612 brought back reports of the animal life whales, polar bears and foxes—and the Dutch Noordsche Compagnie took land for bases as they were doing in Jan Mayen Island and Spitsbergen.

[1] "This island in the year of our Lord 1456 was entirely consumed by fire."
[2] H. Doncker, *Zee-Atlas*, Amsterdam, 1660.

This stimulated the Danish government to send out expeditions to find if there were survivors in the old colonies. In 1721 Hans Egede, a Norwegian missionary, established a new colony, which he named Godthaab; this inaugurated a new era. Danish, Dutch, French, German, Norwegian and American Expeditions have made new discoveries but the work of co-ordination and codification of the new knowledge has been largely in the hands of the Danes who administer the country.

Fortunately it has not proved necessary to rely solely upon scanty literary references for a knowledge of Norse life in Greenland and owing to the peculiar climatic conditions archæology can make an exceptionally valuable contribution. The East Settlement was long looked for in the inhospitable coastlands east of Cape Farewell and only in 1885 did G. F. Holm identify the settlement in the Julianehaab district. Since then excavations by Holm, Nørlund and Roussell, to name but three of the most prominent, have given an illuminating vision of arctic life over five hundred years ago at sites which resemble that at Jarlshof in the Shetland Islands. Humic acids penetrated into the graves and these dissolved the lime of the bones but tanned and preserved connective tissues and clothes. In the skeletal remains found at Herjólfsnes[1] the tallest man was 5·3 ft. (162 cm.) and all the women were under $4\frac{3}{4}$ ft. (145 cm.); most of the skeletons were of individuals under thirty years of age with defective physical development and, in the case of the women, with deformation of the pelvis which would make child-bearing difficult. The teeth too, are very worn, showing that vegetable fibres had been a main item of diet.

The settlements are found in south-west Greenland and from their grouping are now termed East, Middle and West Settlements; the sites are indicated in Figure 131. There is no doubt that the Norsemen, inspired in this case by Eric the Red, had an "eye for country' and were quick to see land suitable for settlement. Selection was made of Julianehaab, in one of the warmest and wettest districts; here grass would grow easily and from charred wood it is known that brushwoods were burnt to encourage the grass growth. Apart from any deterioration of climate which may have occurred subsequently, soil erosion by wind, after over-grazing, has ruined what would in Norse times have been extensive grazings; this trouble is being guarded against with the revival of sheepwalks in Greenland. Most of the ancient sites, known from records, have been identified but some have been lost by landslides, by river erosion and by a submergence of about 16–20 ft. (5–6 m.). A settlement was

[1] For a summary of this excavation see W. Hovgaard, "The Norsemen in Greenland", *Geog. Rev.*, XV, 1925, pp. 605–17.

established at Herjólfsnes, the point of call, but most of the pioneer settlements avoided the barren, foggy fringe and penetrated into the fjord valleys. Churches were built and their structure shows affinity with those of Orkney. House walls were of turf and stone

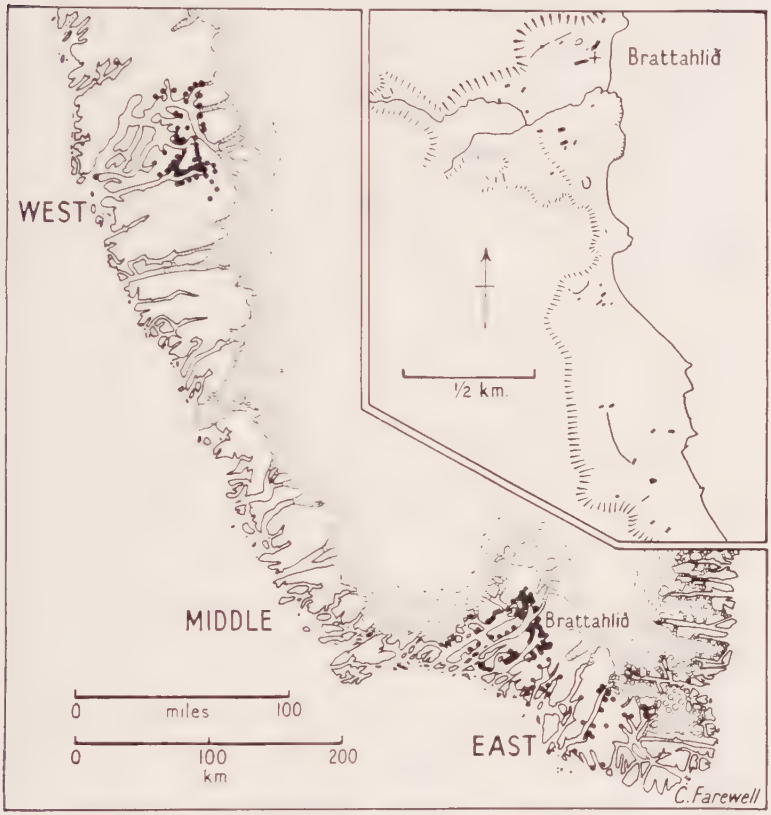


FIG. 131.—NORSE SETTLEMENTS IN GREENLAND.

The location of these settlements is indicated with the modern limit of the ice-cap. Inset is a plan of Brattalið with its church, buildings and sheepfolds lying between the sea and a bluff.

Based, by permission, on A. Rousell, "Farms and churches in the mediæval settlements of Greenland", *Medd. om Grønld.*, 89, Copenhagen, 1941 and F. Nansen, *In Northern Mists*, London, 2 vols., 1911.

and roof timbers were either local birch, driftwood or timber cut in Markland; there is evidence of voyages to obtain this timber. As in Iceland the valley area was taken over by one man and he divided it out among his friends. The house was always built on a commanding site, the infield enclosed by a wall, and the outhouses for the smithy

and the cowshed scattered about in the infield, but the storehouse was situated near the boat landing point and the sheepfolds near the hill country. This is a pattern of settlement still found in the Shetland Islands to this day, although the scale of construction is smaller. At Garðar was the *Thing* site equivalent to the þingvellir of Iceland. With cattle and sheep, food drawn from the seas and firing from driftwood or copses, this did not represent a Land of Desolation to the hardy Norsemen living beside Icelandic fjords and was but a logical extension of their westward migration with the power of the seacraft they had evolved.

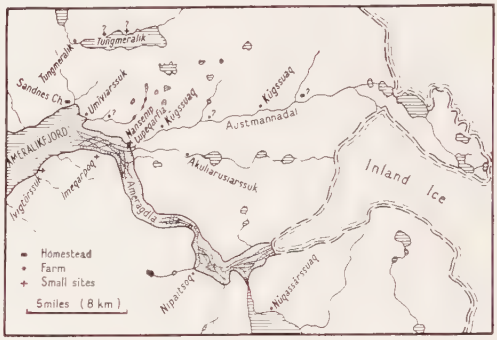


FIG. 132.—AUSTMANNADAL SETTLEMENT.

Situated in West Greenland (50° W. and 64° N.). The Eskimo names are in italics, Norse names in upright style and ? means that the name cannot be identified. Water areas are ruled and silted-up areas stippled.

Based, by permission, on A. Rousell, *op. cit.*, p. 14.

Then the Norse web of life came to an end although they occupied what Rink called the "Garden Eden of Greenland". These settlements, which were believed to have contained 2,000 to 3,000 persons at one time, perished. In 1261 the colonies surrendered their independence to Norway and a royal monopoly, with one ship a year, controlled the trade until the rise of the Hanse power and the spread of the Black Death plague killed Norwegian trade. The Norse lost their supplies of flour and of iron, although some iron ore was smelted in Greenland. Whether the cause was malnutrition, possibly brought about by a deterioration of climate or by insect pests which ate the plants, or by an invasion of Eskimo (Skrællings) exterminating the Norsemen, or by an absorption into the Eskimo stock, the colonies as such disappeared. Thus failed an epic of settlement in high latitudes.

THE ESKIMO

When Europeans revisited Greenland they found Eskimo in territory not occupied by these people at the time the Norsemen entered to establish their colonies, although abandoned dwellings were then noticed. The Eskimo are a people showing Mongoloid

affinities with a cephalic index of 72, an average male stature of about 5·3 ft. (162 cm.), black straight hair, small slanting brown eyes set above broad, rounded cheeks. Thorgils Orrabeinfostre, in a saga which is not reliable, records having seen "two witches" cutting meat off a sea-animal driven on the ice and this must have meant a contact with the Skrællings who seemed to have pressed south in the thirteenth century before the extinction of the West Settlement. These Eskimo people, lacking iron for weapons, have adapted to a harsh environment a culture which, in its traditional form, was so excellent that it is certain no other race could have survived so well without importing goods. The necessity for the exclusive use of bone, teeth, skin and driftwood for all weapons and tools was a handicap nevertheless successfully overcome: from these unpromising materials the now nearly extinct oomiaks were made, boats which could carry over three tons yet themselves be carried across an ice barrier by a few men. What a different vessel from the heavy wooden boats painfully hauled by Parry's men on their attempt to reach the North Pole in 1827! The Eskimo have left traces of their occupancy over a greater area and the most northerly house ruins so far discovered in west Greenland are at Cape Webster, with a fireplace and tent-rings farther north still at Polar Bay. The most northerly settlement in the world is that established as such by Rasmussen in 1910, in the Thule District; 251 so-called Polar Eskimo were living there in 1922. Fresh groups of Eskimo from Ellesmere Land had entered Greenland between 1862 and 1866 and these newcomers re-taught the earlier immigrants the use of the kayak. The story of the area is being gradually unravelled and the movements traced of the groups carrying the various cultures. After the oldest group, the Palæo-Eskimo (Dorset) culture who lived by hunting reindeer and musk-ox using flint implements, there followed the so-called Thule culture, belonging to the Neo-Eskimo complex, of a people who lived on the coasts and hunted whales. The Eskimo chose for their settlements low promontories and islands and, as a result of organic waste, the ruins are green oases. Mathiassen found that the upper layers of a midden at Inugsuk, 10 miles (16 km.) north of Upernavik, contained relics such as coopered goods, spoons, dolls and a lump of church-bell metal which prove contact with the Norsemen of Greenland and possibly represent booty from plundering in the thirteenth and fourteenth centuries. From the relics in the middens it is possible to recognise two streams of Eskimo migration; one, carrying the Inugsuk culture, moved south by the west coast and by Cape Farewell north through Angmagssalik to north-east Greenland where it is believed they met a second stream, carrying the Thule culture, which had travelled by

the north coastal zone. The mixed descendants of the two cultures were seen in 1823 by Clavering, at the island which bears his name, but these people are now extinct.

The present northerly peoples depend for their existence upon dog-sledges and there can be little use of kayaks in the heavily frozen seas. There is a little hunting of musk-ox in north-east Greenland but not of reindeer for these are confined to the south-west. Seals are caught at the breathing-holes or where an open lead in the ice results in the congregation of seals. Farther south is the so-called Sub-Arctic culture with a mixture of hunting, using kayaks and of cod-fishing, while in the Arctic culture farther south kayaks are in use most of the year. Migration has occured among the Eskimo peoples in recent years as a result of changing conditions, such as the diminution of seals off south-east Greenland, owing to European over-catching: with some species of seals, excessive killing on their long annual migrations may later mean shortage for peoples living a great distance away. The south-east, long outside Danish influence and with heathen Eskimo, had in 1829–30 about 600 natives, but by 1884 there were only 135. When Angmagssalik was colonised in 1894 the numbers increased again. The last families left Tingmiarmiut at the turn of the century. The ice off the east coast of Greenland made it difficult to approach and the heathen Eskimo had to carry their produce by oomiak to the trading station at Julianehaab though access was eased by the introduction of steamships. Because of pressure on resources 70 Eskimo moved to Scoresbysund on the founding of that settlement in 1924–5.

The present Eskimo stock differs from that of the past in that there has been a great admixture of European blood, chiefly Danish; the purest stock is found in the isolated districts of Julianehaab, and in the north-west. In 1820 the people of mixed blood were estimated at 14 per cent of the total population, in 1855 at 30 per cent and now the races are too intercrossed to distinguish. It is said that the mixed blood of the Greenlanders, as they should now be termed, is more vigorous than that of the pure Eskimo. The old independence is disappearing but with it some of the oscillation in food supply from glut to starvation. From Rink's volume, still a valuable statement of the old ways of life we read (pp. 184–5) of the food supply which in 1870 averaged per head each day: 2 lb. (0·9 kg.) of flesh and blubber, 1½ lb. (0·7 kg.) of fish, 2 oz. (0·04 kg.) of bread, barley and peas and mussels, berries and seaweeds. Though it proved satisfactory, it was an unbalanced diet with the only fresh vegetable foods supplied by crow-berries and *Archangelica officinalis* (a species like celery which grows about 7 ft. (2·1 m.) high in the south and is eaten raw). Animals supplied most of the raw materials for existence

and hunting proved precarious with uneven catches, so that the Greenlanders were not unwilling to trade with ships and stores for alternative foods. During the war fear was felt that undue dependence on the waste food from the air-bases would cause trouble later but a death from ptomaine poisoning made the people afraid of this source and preserved the century-old system of the Danish adminstrators of selling suitable goods only (see p. 373); by this means the Danes had sought to isolate the Greenlanders and to protect them without pauperising. In the vivid words of Mathiassen: "Civilisation has now come to the Greenlanders. In south Greenland fishing has more and more displaced seal hunting; the yawl and motor-boat have succeeded the kayak and woman's boat, the rubber boot, the kamik shin-boot; the gun, the harpoon; and the wooden house, the old turf hut. The old Eskimo culture in Greenland will soon exist only in the old house-ruins and graves, and in the museums."

MODES OF LIFE

The climate is severe and the soils are poor so crop-growing is generally impossible except for experimental garden crops, such as potatoes, at Godthaab and Julianehaab. Trees are rare but there are copses of stunted willows, birches, mountain ash, junipers and alders. The tallest tree in Greenland is to be found inland from Tasermiut fjord; it is 14 ft. (4 m.) high but owes its height to growing in a cleft between two boulders. Growth is tardy, for one willow stem, barely an inch (2·54 cm.) in diameter, had about a 100 annual rings; with the frozen subsoil roots run horizontally and the volume of soil for nutriment is limited. The valley floors in the southern dales are covered with green grass, heather and shoulder-high thickets. The meadows in north-east Greenland are rich enough to support herds of musk-ox which are hunted and not domesticated. In the south pastoral farming, practised since the middle of the eighteenth century, has been increased by the establishment in 1915 of a sheep station at Julianehaab: in 1931 the sheep flocks of Greenland numbered 2,000, in 1935 8,000 and in 1951 14,000 sheep. The sheep provide knitting wool and the carcases are kept in cold store for use in Greenland. Fortunately, as yet, the sheep flocks have not been attacked by foxes as has occurred in Iceland. Winter fodder is a problem, with hay and seaweed as the staples. There are few cattle on account of the scanty fodder supplies and goats are kept for milk.

Hunting has passed its peak in the economy of Greenland. Bræstrup has shown how in the north the foxes live on lemmings

while elsewhere along the coasts of Greenland they depend upon sea products, birds and eggs. Years in which lemmings are prolific are followed by years of scarcity so the number of pelts obtained fluctuates in response; the periodicity of the lemming maxima is about four years. In the south of Greenland there is also a periodicity in the plentiful and sparse years for hares and ptarmigan which influence, but do not control, the numbers of foxes caught; it may be the result of climatic fluctuations. Along the coastal zone are hunters' lodges for trapping foxes. The Greenlanders still go hunting for reindeer but it is not now their mainstay. In the period 1845–9 there was an annual killing of 25,000 reindeer and 16,000 skins were exported but in 1868–72 only 1,000 a year were killed, for the introduction of firearms had resulted in over-killing. The sea has provided a more permanent source of wealth to the Greenlanders. Disco Island, known to the Norsemen as Bear Island, was used by the Dutch in about 1650 as a base for whaling and trade and in 1773 became the site of Godhavn. Whales of sixteen species have been recorded as occurring in these waters; the Greenland Whale was once common but the numbers were unduly reduced, as it gave the finest whalebone, and it is now protected. Whaling by the Greenlanders was a spasmodic event and the best catches were obtained when rapid freezing of the sea caused schools to congregate to try and keep the water open. The Caa'in whale, as in the Færoes and the Shetland Islands also entered the fjords and could be run inshore in numbers; in 1924 some 200 were so captured at Sukkertoppen. The white whale can occasionally be driven into a fjord and shot with a rifle. A small whaler is kept in these waters by the Danish Government and after the blubber has been flensed the carcase is handed to the Greenlanders for meat.

Sealing is also important; it was once paramount as the supply source of skins for clothing, kayaks and oomiaks, of sinews for thread and of blubber for food, light and heat. The bearded seal was particularly valuable as its thick skin could be used for ropes, but the ringed seal, which does not migrate or herd together, was the commonest and of greatest general utility. Rink records that about 1875 the catch averaged 89,000 seals, 700 white whales and narwhals, and 2 or 3 large whales and that from these 2,050 tuns[1] of blubber were obtained of which nearly a third was consumed in Greenland. Trangraven (Train-oil wharf) in København has always been used for the Greenland trade by the Kongelige Grønlandske Handels (Royal Greenland Trading Corporation), and its name commemorates the staple which is rendered down from the seal and whale fat.

[1] A tun = 252 gallons = 1,146 litres.

Fishing has now become the basic industry owing to a slight rise in the temperature of the sea-water, drawing shoals northwards along the shores of west Greenland. Cod were formerly only found off south Greenland but in 1919 they migrated to the Godthaab district, in 1929 to Egedesminde and by 1931 into the Ũmánaq district. By 1935 the catch was 4 million lb. (18,140 quintals) a year and this allowed the population of West Greenland to increase from 13,917 in 1921 to 28,919 in 1959. Previously capelin, which come in vast

A.C.O.] [*August, 1953*

FIG. 133.—VESSEL FOR THE GREENLAND FISHERIES.

This wooden Canadian corvette, converted to a fish processing base ship for the cod fisheries of West Greenland, is lying at the head of Trongisvágur to complete her complement of crew. This vessel was to proceed to Greenland, make voyages with a cargo of frozen cod fillets to New York and to Boston before returning with a cargo to Copenhagen.

numbers into the fjords to spawn, had been the chief species of fish caught for food of humans and dogs. The Mackenzie and other rivers of North America deliver vegetable debris to the Arctic Ocean and some of this drifts eastwards towards Greenland where it provides food for vast numbers of fish, the number of species of which is very limited. A wedge of the current from Siberian shores rounds Cape Farewell and passes along the shores of west Greenland so that the waters are of mixed origin. Detrital material is also brought by the icebergs and off Jacobshavn it is found that Greenland halibut congregate to feed where the icebergs ground on banks in the

fjord and melt. Jacobshavn, once a poverty-stricken colony, has become prosperous as a result of the fishing whereas halibut are no longer caught at Holsteinsborg and the fish-cannery, which employs up to 80 girls, now packs crabs and deep-sea shrimps. Red-fish and

FIG. 134.—GREENLAND LANDSCAPE.

The top left-hand figure shows the glaciers moving down to the sea and the trails of moraines from rock outcrops. The bottom figure shows the site of Holsteinsborg—the settlement is scattered at the base of a low hill and alongside sheltered water. Electricity cables are shown by a fine dotted line.

Based, by permission on *Grönland, 1:250,000* No. 66 ö. 2 Schweizerland and *Grönland, 1:2,000* Holsteinsborg published by the Geodætisk Inst. ,Köbenhavn.

cod are also caught in great quantities: in 1951–52 11,072 tons of cod were caught and sold to the Royal Greenland Trading Company and preserved by salting and drying. Four ports are open for Færoese fishermen, the largest and oldest being Færingerhavn, south of Godthaab, and their large cutters with a crew of 30 men, engage in

deep-sea fishing. The Greenland shark, which lives in the fjords as well as the open sea, is caught; as many as 50,000 were captured in a single year pre-war, and the liver, with its oil content, and the skin are sold on the European market while the flesh, which is poisonous when fresh, is dried for dog-food.

Great numbers of seafowl nest and the auk is an alternative to fish in the diet. Thus the sea provides, directly and indirectly, a valuable supplement to the diet and to the trade. The annual average exports from 1853–72 of native-produced goods were 7,185 tuns [1,358,000 litres] of purified oil, 35,439 sealskins, 1,436 fox pelts, 41 bear skins, 881 waterproof jackets, 1,003 waterproof trousers, 3,533 lb. [1,600 kg.] of eider-down, 6,900 lb. [3,150 kg.] of feathers, 2,300 lb. [1,050 kg.] of whalebone, 550 lb. [250 kg.] of narwhal ivory, 87 lb. [39 kg.] of walrus ivory and 1,817 reindeer hides. Many of these items have dwindled to negligible quantities but the sea still provides the mainstay of the exports produced by the native Greenlanders: the scale of production can be gathered from the following Table which also shows the domination of the hunting economy in Thule and East Greenland.

Greenlanders' Sales to Royal Greenland Trading Co., 1950–51

Hunting and collecting				*Modern fishing*		*Pastoral*	
	West Greenland	*Thule*	*East Greenland*	*West Greenland only*		*West Greenland only*	
Feathers and eider-down, tons	10	—	—	Cod, cleaned, tons	13,059	Wool, tons	4
Blubber and whale-oil,* tons	733	4	17	Halibut, tons	254	Live sheep and lambs, no.	207
Walrus hides, tons	8	2	—	Salmon, tons	21	New-born lambs no.	143
Seal-skins, no.	10,825	2,235	5,408	Shark-skins, no.	1,454	Lamb and sheep skins, tons	4
Blue fox-skins, no.	2,131	642	74	Wolf-fish skins, no.	100,150		
White fox-skins, no	1,321	528	394	Shark and cod-liver, tons	866		
Bear-skins, no.	4	—	84	Shrimps, tons	176		

* Part of this entry should be under "Modern Fishing" since it is obtained from a whaler as well as by more primitive methods.

[Based on *Statistisk Årbog*, 1952, p. 311

MINERAL RESOURCES

Minerals are of some significance in Greenland since royalties for the mining of ore have paid for many of the services rendered to Greenlanders. Steatite (soapstone) was used by the Norsemen and Eskimo for lamps and pots but its value has now disappeared while masses of native or meteoric iron occur near Cape York and were formerly used by the metal-hungry Eskimo. At Qutdligssat there is a horizontal coal seam about 3¼ ft. (1 m.) thick which is mined to

supply most of the coal needs of Greenland. Mining is carried on throughout the year and the output is stored in a dump. There is no steamer pier and the deep water channel between Disco Island and the mainland is offshore and exposed, so the coal has to be carried in small trolleys and tipped into lighters which, in fine weather, carry the coal to the ships for loading. Mining started in 1906 and

Photograph by courtesy of J. Coull] [*August, 1956*

FIG. 135.—MINING CAMP AT MESTERSVIG.

This is the base for lead mining being prosecuted by a Danish-Canadian consortium in East Greenland.

there are several outcrops which have been hewn by the local inhabitants and the coal surplus to their needs sold to the State stockpile: from the mine at Qutdligssat 5,566 tons was won in 1950–51. Unfortunately the coal has sometimes been baked or burnt by basalt and its value destroyed. Graphite has been mined at Amilsok and near Upernavik and small quantities sent to Denmark. Marble was quarried at Marmorilik, on Ūmánaq fjord, before the war and with a hundred workers there was a considerable output which was sent to Denmark. This is a desolate fjord and a difficulty was the supply of fresh food to the workers.

Although lead and copper ores, asbestos and mica occur they are insignificant beside the occurrence of cryolite (Gk. *Frost-stone*) which is worked by a corporation whose capital comes half from the government and half from private sources. This rare sodium-aluminium fluoride is of considerable industrial value for enamelling ironware, for producing opalescent glass and as catalyst in the manufacture of aluminium. The quarry at Ivigtût was first opened out in 1857 and is now an open pit 200 ft. (61 m.) deep for the production has been considerable: between 1857 and 1863 14,000 tons were quarried, from 1864 to 1870 the average production was 10,000 tons; thereafter output decreased but, with growing demand for aluminium it rose to 23,800 tons in 1924 and 48,501 tons in 1938. At present the output is about 42,000 tons a year with three-fifths of the production going to København and most of the rest to Philadelphia. The cryolite is blasted by dynamite and the broken material is placed in tip wagons which are hoisted to the surface and then hauled by locomotives to the wharf, there lifted by a crane and the load tipped into the hold of the ship. A fleet of carriers is owned by the cryolite company. Greenlanders are not allowed to work in the quarry and the 125 European workers are housed at Ivigtût. At Mestersvig, north of Scoresbysund, an airstrip has been laid out and a large company is doing exploratory work to test the scale of the lead deposits and is installing a concentrating plant to handle the ore for despatch by air.

POPULATION

The population density in Greenland is very slight and as Loewe pointed out the population should be related to the coastline occupied or to the area of water hunted or fished; for example, in the Ũmánaq Bay area one inhabitant to every 2 miles (3 km.) of coast or one to every 2¾ sq. miles (6 sq. km.) of water. The population has increased to 29,200 Greenlanders, about half the Eskimo population in the world, despite the curse of tuberculosis, for the birth-rate is 43 per thousand, higher than all European rates, and the death-rate is 27 per thousand. To combat the tuberculosis, the Danish Government have established several sanatoria. In the past the population has suffered from time to time from severe epidemics, such as that of smallpox in 1734–5 when at least 2,000 Greenlanders died. Formerly the roofs of the turf huts used in winter were taken off in summer while the families were away hunting, using reindeer skin tents, but since wooden huts have become permanently occupied, sanitation has become a problem. In the past cold and starvation killed many, as in the years 1844, 1853–4 and 1856–7. Male deaths were

frequently due to accidents when sealing from kayaks; about one death in twelve was so caused in the heyday of this activity.

The population is located at settlements round the coast and these are grouped in "colonies" (the term used for all the chief places), the central administrative point being equipped with a school, church and store. There are subsidiary outposts to the main settlement in each district.

Population by Districts, 1870, 1927 and 1950

	Founded	1870, according to Rink		1927			1950	
		No. of settlements	Population	No. of out posts	Greenlanders	Europeans	Greenlanders	Europeans
South Greenland:								
Julianehaab	1755	54	2,570	8	3,518	26		
Frederikshaab	1742	15	821	3	981	5		
Godthaab	1721	14	999	4	1,276	37		
Sukkertoppen	1755	6	765	3	1,363	17		
Holsteinsborg	1759	9	545	3	876	7		
North Greenland:								
Egedesminde	1759	22	1,008	6	1,646	14	20,754	907
Christianshaab	1734	8	481	3	599	2		
Jacobshavn	1741	10	424	2	653	19		
Ritenbenk	1755	8	447	3	679	8		
Godhavn	1773	7	245	3	400	21		
Ûmánaq	1758	15	798	8	1,406	19		
Upernavik	1771	9	702	8	1,152	16		
Thule	1910	0	0	0	284	0	338	36
East Greenland:								
Angmagssalik	1894	1	800–1,000	0	696	9	1,489	118
Scoresbysund	1924	0	0	0	105	4		

N.B. Ivigtût, founded in 1864, had in 1927 about 125 Europeans and is included with Frederikshaab for administrative purposes.

All the "colonies" are now Danish, but formerly the Moravians, a German religious order, had four stations and two outposts in the south.

CONCLUSION

In 1261 the Norsemen submitted to the Norwegian Crown but later the Kingdoms of Norway and Denmark were amalgamated and it was the Danish Crown which restricted trade in 1691. Meanwhile, however, whalers continued trading and in 1721 the efforts of

Hans Povelsen Egede, a Norwegian pastor, caused the resumption of the Scandinavian trading connection and a joint stock company was founded in Bergen to prosecute trading, colonisation and missionary work. Although six years later the company was liquidated and in 1727 the administration was transferred to København, the keynote has in the following centuries been maintained on this Christian note of helping the Greenlanders and not merely on that of exploitation. In about 1735 a monopoly of trade for six years was granted to Jacob Severin but there was still interloping on a large scale by whalers from the Netherlands, Bremen and Hamburg, and in 1739 armed Danish ships captured five Dutch vessels. In 1747 a concession was granted to the Danish General Trading Company for 40 years but in 1774 it was made a royal monopoly and meanwhile the Dutch had agreed not to trade with the natives. During the Anglo-Danish war of 1807–14 contact with Denmark was broken but the English sent food to Greenland. In 1835–40 a Commission met to consider ways of improving conditions for the Greenlanders and in 1862–3 Dr. Henry Rink who, with Egede, was a leader of inspiration for the benefit of the natives, created Boards of Guardians. All trade and administration is in the hands of the Government Board, *The Royal Greenland Trading Company*. After the First World War the Norwegians tried to colonise the north-east for hunting and sealing but in 1933 the Hague Court upheld the claim of Danish sovereignty over the whole territory. The west coast north of 67° 40′ N. was administered from Godhavn and south of that latitude from Godthaab, and the east directly from København, but as a result of an Enquiry in 1950 the Councils at Godhavn and Godthaab have been replaced by a central council and the control by København is reduced.

Thus there has been some relaxing of outside administration although the communications have been speeded up and telecommunications are efficient and rapid. Sailing-ships used to take, on an average, 34–44 days from København to the south-west of Greenland though the return voyage was quicker. In 1888 auxiliary steamships replaced those dependent upon sails and since 1898 steamships have been successfully employed but oak hulls have proved better than steel to deal with ice. Seaplanes have helped to open up the country and during the war the United States constructed the great air base of Blüie West One, in the Julianehaab district, with a long concrete runway and a town to accommodate several thousand airmen. Blüie West Eight was also constructed at the head of Søndre Strømfjord and in 1954 was re-named Søndre Strømfjord and utilised as a point of call for the S.A.S. route from København to Los Angles. Since the war the Blue Jay base,

one of the largest air-bases in the world has been constructed in Thule.

The old life has largely gone and the primitive stone and turf dwellings are being replaced by a Danish-type of wooden house with a steep roof to shed snow. The heat of these buildings in winter may keep the subsoil thawed and springs have been known to well up in the floors of these modern buildings. Trade has changed and, largely as a result of the great influx of airmen during the war, a demand for souvenirs was created. During the war the Greenlanders were protected from the impact of American ways of life but they were given certain physical assets—airstrips, meteorological stations, spacious warehouses on Transit Island (Egedesminde)—which, if used, will inevitably enlarge contacts with the outer world. Only at isolated Thule, with one ship calling a year, do the Greenlanders still carry all their belongings on sledges, build igloos and carry children in shoulder-bags but this mode of life has only been maintained by preventing contact between the Greenlanders and the men at the enormous Blue Jay air-base.

In this Arctic land the Scandinavian peoples have played a notable part; nearly a thousand years ago they revealed this land to Europe, established settlements and introduced Christianity. The first group of settlements failed but in the eighteenth century a new chapter was started and the Danes have given to the Greenlanders an opportunity of survival. While there have never been large settlements of Scandinavians, this is the western fringe of the Scandinavian World and has been the scene of epics of colonisation—ancient and modern —connected to the homeland by tenuous contacts.

PART III

ECONOMIC GEOGRAPHY

CHAPTER 15

AGRICULTURE AND ITS PRODUCTS

Agricultural activities provide an appreciable portion of the wealth of most of the Scandinavian World, despite the northerly latitudes and the generally poor soils and severe conditions, and the basic pattern of settlement is inseparably linked with farming, whether arable or pastoral. The physical controls have been considered in Chapters 2 and 3 while the regional chapters give accounts of the development of agriculture in the various countries, but it is appropriate here to gather the principal threads together and to assess the relative value of agriculture in Scandinavian economy. While the physical controls apply in detail a general pattern is also discernible and this may be briefly analysed under the headings of relief, soils and climate.

RELIEF

While the height of the land in itself does not greatly affect plant growth it does modify the climatic conditions and, since in Scandinavia these are so often marginal for successful crop-growing, the arable areas do not spread high up the mountain sides, with the result that the northern limit of crops is farther south in the mountainous regions than in lowlands. Slope and aspect are locally more important than the absolute height of the land and may reverse the effect of relief on the distribution of a crop. In deep-set valleys, apart from temperature inversion and frost-damage, control is also exercised by hill-shadows which reduce the amount of insolation which may be received.

SOILS

Soils are more important in Scandinavia than climate in controlling the intensity of cultivation. One of the dominant features in soil formation in Scandinavia is leaching, which is most serious in the older soils and those of coarser grain through which water can percolate most easily. Underlying these pale podsol soils is a

darker horizon which may form a hardpan which inhibits plant growth. In the finer-grained clay areas brown soils tend to be formed. These clay soils have the further advantage of being free from boulders but they may require considerable applications of lime to produce good crops. The soils of Iceland and the Færoes are derived from basic igneous rocks and have a high phosphate and iron oxide content but a marked deficiency of calcium carbonate. One of the most fortunate features of Scandinavian soils is that those naturally richest in lime are generally found towards the south where relief and climatic features also are usually most favourable for crop growth.

PEAT RECLAMATION

Vast areas of the Scandinavian countries are covered with peat which profoundly affects the surface soil. Many areas nov peat-covered have climatic conditions which do not encourage peat growth and these areas represent relics of a post-glacial climatic period which was conducive to peat formation and the deposits are now in process of decay. Numerous peat reclamation works have been attempted in the Scandinavian countries: that at Vildmose near Ålborg in Jylland operated by the Danish Government since 1921, that at Ås by the Norwegian Agricultural College and that at Flahult near Jönköping by the Swedish Peat Society can serve as examples. The Scandinavian countries have various societies which differ in constitution but are all voluntarily organised groups to encourage the reclamation of waste land: in Denmark the Danish Heath Society was formed in 1862 and was followed by similar bodies in Sweden (1886), Finland (1894) and Norway (1903). In addition there is reclamation work carried out by private people and by communities. The systems of reclamation are:

A. Removal of the peat followed by cultivation of the skinned surface; owing to the poverty of the leached soils this is not satisfactory without liberal manuring.
B. Cultivation of the surface of the peat after treatment which can be:
   (i) Burning of the dried surface.
   or (ii) Drainage and then applications of dung, sand or clay. This method improves the soil texture and claying, an old technique, is practised in Finland for it reduces the quantity of lime required. These methods are expensive and the technique is tending to be abandoned.
   or (iii) Special cultivation machinery is used after drainage and then lime and fertilisers are applied.

Peat soils, other than fenland, are deficient in lime; in Denmark this is supplied as marl but elsewhere ground limestone or burnt lime has to be transported to the area, often from great distances. These soils are also deficient in phosphoric acid, potash and nitrogen and so artificial fertilisers have to be applied as the supplies of farmyard manure are insufficient. Much of the land reclaimed in Sweden is laid down to grass after one rotation of crops and it is clear that the area of permanently improved land can be greatly increased, though at the cost of expensive draining and fertilising.

FERTILISERS

Owing to the mineral deficiencies of many of the soils it has been necessary to apply fertilisers on a considerable scale and the quantities applied, particularly of phosphates, have been greatly increased in the post-war years.

Fertiliser consumption, '000 tons

	Phosphates (By P_2O_5 content)		*Nitrogenous fertilisers (By nitrogen content)*		*Potash fertilisers (By K_2O content)*	
	1938	*1959/60*	*1938*	*1959/60*	*1938*	*1959/60*
Denmark .	64·3	117·2	51·3	122·8	45·8	179·4
Finland .	26·6	87·6	8·4	52·7	16·2	66·7
Norway .	15·3	48·0	10·5	48·8	21·5	45·2
Sweden .	53·2	108·4	29·7	104·0	55·3	86·2
Iceland .	—	3·9	—	7·1	—	2·1

(Based on *U.N. Statistical Yearbook, 1961*, Tables 98–100)

Sweden has about four and a half times the area of the arable land of Norway, Denmark four times and Finland three times. If the fertiliser consumption is considered against these relative areas for the year 1959/60 it shows that in Finland, Denmark and Sweden the arable land is not receiving so much artificial fertiliser per acre as in Norway and this may be due either to a smaller need, soil fertility being maintained by greater supplies of manure and less potent leaching in the drier areas of Scandinavia, or it may be that Norway with her great electro-chemical works has progressed further with the utilisation of fertilisers. Since the war the Norwegian government has heavily subsidised the use of fertilisers. In Finland it has been calculated that 5 lb. per acre (10 kg. per ha.) of nitrogen, 15 lb. per acre (30 kg. per ha.) of phosphoric acid and 7 lb. per acre (14 kg. per ha.) of potash must be applied to cultivated land to supplement the supplies from manure. In 1950 only about half the

nitrogen and two-thirds of the phosphoric acid and potash required were applied, and in order to increase supplies three superphosphate factories are now working, using imported crude phosphate, and a nitrogen factory has been established.

Undoubtedly it is necessary to add minerals to the soil, and the soil deficiencies, particularly in respect of sugar-beet cultivation, have been scientifically examined in Sweden. The need for lime has long been appreciated and in about half the area of Sweden the annual lime requirements are of the order of 40 tons of pure lime per sq. mile of arable land (25 tons per sq. km.) and this deficiency partly accounts for concentration of the arable areas of Sweden in the districts of lesser lime requirement.

CLIMATE

Among the climatic features affecting agriculture are thermal conditions, insolation and precipitation and of these the first is the most important general factor in Scandinavia.

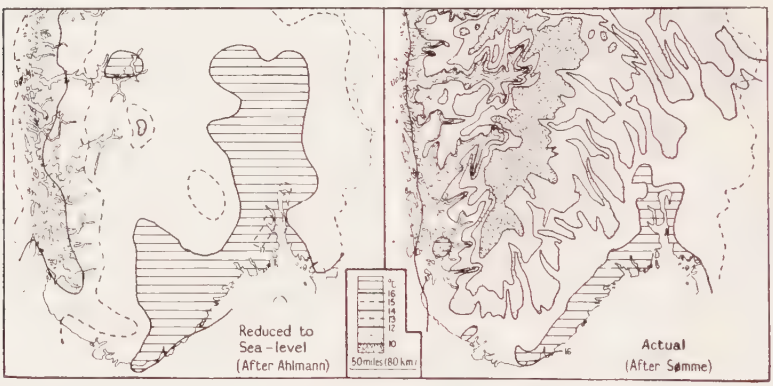


FIG. 136.—ACTUAL AND "REDUCED" JULY ISOTHERMS IN SOUTHERN NORWAY.

For most isotherm maps temperatures are reduced to sea-level values and in regions of high relief, such as Norway, the view of higher temperatures so presented may be misleading. The right-hand map indicates recorded temperatures which reflect changes of aspect and altitude and thus appears more complicated but is nearer the actuality. Both maps do reveal the difference between the cool maritime fringe and the more continental summer of the Oslo region.

Based, by permission, on H. W:son Ahlmann, *op. cit.*, Fig. 19 and A. Sømme, *Jordbrukets Geografi i Norge*, Bergen, 1949, Plate II.

Even Finland feels some maritime influence, seen in the temperature cycle through the year, with a reduction in the summer maximum compared with more continental areas in the same latitude. Average temperature maps indicate, to some extent, the opportunity for growing crops but deductions drawn from temperatures reduced to

sea-level datum are inaccurate. It might be more useful to aggregate the temperatures exceeding 41°F. (5°C.) in the period of growth, for this is a measure of the ability of plants to grow in an area: as an example southern Finland aggregates 2,070°F. (1,150°C.) in about 200 growing days whereas at the Arctic Circle, with 165 growing days, the aggregate is only about 1,350 F. (750°C.). The latitudinal extent of Scandinavia—over 15°—results in a difference of length of growing season of some two and a half months in favour of the south, although this is partly compensated by the greater number of hours of sunshine it is possible to receive towards the north in the days near the summer solstice. The length of growing season can be measured either by the time between killing frosts or by the period when the mean temperatures exceed 41 F. (5°C.). With improved varieties of crops it is possible to advance northward successful cultivation of the land.

Frost liability in the growing season is greatest in the marginal areas of the north and crop failures are often a result of frost. The period of the frost affects different crops: spring and early summer frosts damage orchards and the spring grains while late summer frosts may ruin the potato harvest. Some areas are less liable to frost damage than others: moving water and large water bodies reduce the danger while in deep-set valleys frost may develop through temperature inversions. Ameliorative measures include care in making clearings in the forest aligned so as to reduce the possibility that calm, cold air is trapped inside them.

Insolation, as expressed in hours of sunshine, tends to be greater in the north during the summer because of the longer hours of daylight but the effect of this is not in a simple ratio to length of daylight for the intensity is less with a lower angle of incidence, and there is more cloud cover in the north. Thus the differences between north and south are not so great as a cursory examination of Figure 17 would suggest.

The amount of precipitation affects plant growth and the period of fall also has an effect even in these northern countries where losses by evaporation are relatively slight. A heavy snow cover, which prevents most domestic animals from wintering out of doors protects perennial crops and winter cereals, and while the cold melt-waters retard plant growth—not altogether a handicap as the danger from late frosts is thereby reduced—they do give a supply of water ready for plant growth when the air temperatures rise above 41 F. (5°C.). The August maximum of precipitation in Finland retards the ripening of the crops, but drought in summer affects grass growth in Finland and south-eastern Norway: in the latter case irrigation of grasslands has long been practised (see p. 218).

LAND USE

It may be appropriate at this point to sketch a general picture of the present land use in the Scandinavian lands. As the following table shows, Denmark has proportionately over eight times as much of its area devoted to crops as compared with its neighbour, and nearest arable rival, Sweden, though in actual acreage of arable land

Land Use, 1960

	Land area		*Percentages*			
	'000 acres	*'000 ha.*	*Arable*	*Meadow and pasture*	*Forests and woods*	*Other*
Denmark .	10,620	4,304	64·7	8·0	10·2	17·1
Finland .	74,800	30,540	8·5	0·9	71·1	19·5
Iceland .	25,190	10,027	0·01	22·7	1·0	76·3
Norway .	76,250	30,864	2·7	0·6	22·8	73·9
Sweden .	101,800	41,119	8·8	1·7	54·8	34·7

(Based on *U.N. Statistical Yearbook, 1961*, Table 1)

Sweden exceeds Denmark. Meadow and pasture forms the greatest agricultural land category in Iceland and the second in Denmark. Land agriculturally unproductive ("forest and woods" and "other") includes towns as well as lands generally waste but the latter may have some grazing value for reindeer, cattle and sheep. Even though the livestock capacity of this land may not be great per unit area, the vast extent of grazing land, as in Iceland, means that the aggregate numbers of livestock are considerable.

AGRICULTURAL POPULATION

In Finland, Norway and Sweden it is difficult to assess precisely the degree of dependence upon agriculture for many of the agricultural holdings have associated forest land while in Norway and the Færoes fishing is often associated with farming. Taking the numbers engaged in agriculture during this century, they may be considered absolutely or relatively; with the rise of non-agricultural groups, agriculture as a source of livelihood may maintain as many people now as in 1900, but its relative importance has declined in most of the Scandinavian countries.

AGRICULTURAL PRODUCTION

Two World Wars, with their disturbance of normal trading activities and emphasis on self-sufficiency, have altered the agricultural regimes. In the immediate post-war period only Sweden had increased her output of food while the most war-racked country, Finland, was only producing three-quarters of her pre-war output.

Indices of Agricultural Production
(Note change of index base)

	All commodities	
	1946 1934–8=100	*1959* 1952–6=100
Denmark . . .	97	115
Finland . . .	75	113
Norway . . .	98	100
Sweden . . .	104	95

(Based on *U.N. Statistical Yearbook, 1958*, Table 9, and *ibid., 1961*, Table 12)*

* Indices calculated by FAO and comparisons between years for a country accurate but inter-country comparisons more doubtful owing to different reliability. "All commodities" includes textile fibres and food. It also includes livestock but does not count twice animal fodder grown in country.

Within five years all of the four greater Scandinavian countries had exceeded their pre-war output of food and fibres. The expansion shown in the table above was not of course uniform for all commodities produced and the main divergences can be seen if this Table be compared with the four following Tables which are based upon statistics published by the United Nations Statistical Office.

CROPS

Except in Iceland where the agriculture has always been based on grasslands these northern countries have from time immemorial been growers of grain. In the more northerly regions the hardy 6-rowed barley (bere) formed the staple and elsewhere rye was the principal bread grain, for only in the warmest and most fertile districts of the south could wheat be grown. The northern limits of individual crops have varied with time but there has been a tendency in the twentieth century to push the limits northwards as hardier or more rapidly ripening varieties have been bred. In these marginal lands there has been some improvement of soils, and by growing only on the land better suited to a crop, yields per acre are not inconsiderable and, indeed, are quite high in Denmark.

Metric tons of crops per acre
1938 and 1960

	Denmark		*Finland*		*Iceland*		*Norway*		*Sweden*	
	1938	*1960*	*1938*	*1960*	*1938*	*1960*	*1938*	*1960*	*1938*	*1960*
Wheat	1·3	1·6	0·6	0·8	—	—	0·8	1·0	0·9	1·0
Rye	0·7	1·2	0·6	0·7	—	—	0·8	1·0	0·7	0·9
Barley	1·3	1·5	0·5	0·8	—	—	0·8	1·1	0·8	1·1
Oats	1·0	1·4	0·5	0·9	—	—	0·8	1·1	0·7	0·9
Mixed corn	1·0	1·2	0·5	0·9	—	—	0·9	1·1	0·9	1·0
Potatoes	6·5	8·6	6·1	8·5	4·5	4·5	7·4	8·9	5·4	6·3
Sugar beet	15·1	16·5	9·3	11·1	—	—	—	—	14·6	19·3
Fodder roots	23·2	?	10·6	?	—	?	15·0	?	14·9	?

(Based on *U.N. Statistical Yearbook*, *1951* and *1961*, various Tables)

There has been a progressive increase in the yields per acre in this century; in Finland, for example, the increase has been very substantial and this has helped the country to become nearly self-supporting in essential foodstuffs.

Selected Crop Productions, 1934–8 and 1960
'000 metric tons

	Wheat		*Rye*		*Barley*		*Oats*		*Linseed*	*Potatoes*
	1934–1938	*1960*	*1934–1938*	*1960*	*1934–1938*	*1960*	*1934–1938*	*1960*	*1960*	*1960*
Denmark	383	320	262	454	1,103	2,801	1,024	681	1	1,733
Finland	142	368	340	186	175	440	654	1,109	—	1,717
Norway	56	23	—	—	122	400	183	173	—	1,247
Sweden	696	824	409	230	213	847	1,257	1,176	2	1,753

(Based on *U.N. Statistical Yearbook*, *1951* and *1961*, various Tables)

There is a tendency to sow winter wheat, instead of spring wheat, because owing to the shortness of the summers spring wheat yields are slighter and often cannot compete with other crops. Winter wheat requires for full development a heavy, mineral-rich soil with a high content of lime and this calls for careful soil management. Although it is demanding as a crop the large yields possible encourage its cultivation at the expense of winter rye or of spring wheat, which has a quarter less yield. By drainage and marling, and by abandonment of less suitable land, the average yields of wheat per acre have been increased. Political desire to be independent of imports has encouraged wheat cultivation using the new

quick maturing varieties: for example in Finland between 1911 and 1935 the country reduced its wheat imports from 98 per cent of the consumption to 33 per cent and in 1947 the area under wheat exceeded that of rye for the first time. To achieve this, winter wheat cultivation, which in 1908 was confined to the extreme south-west, had extended by 1933 to a line joining Kotka and Tampere, with an outlying area of cultivation in Ostrobothnia, while spring wheat, which in 1922 had only extended as far north as 63° 20′, was by 1946 being grown almost as far north as the Arctic Circle on the frontier with Sweden. Wheat grown in Scandinavia is rather soft and requires blending with harder wheats to produce a high-grade flour.

Rye requires less moisture and can grow in poorer soils than wheat but now it is displaced from its pre-eminence as a bread grain, partly because of its tendency to lodge and partly because it is less productive, and is mainly confined to the districts of very poor and light soils. Winter rye is grown as far north as Lapland.

The 6-rowed barley is the least exacting of the cereals on soil and climate, and as it can ripen early in the continuous light of the north it has the greatest extension poleward of the cereals and is grown in northern Lapland. By contrast the 2-rowed barley, useful for malt, requires fertile, lime-rich soil and a warm climate and so it is grown in the southern lowlands. Barley is used as a bread cereal in Finland but most of the Scandinavian output is for malting and animal feeding.

Oats, comparatively hardy, can exist on poor acid soils but the yield is then light so it is, if possible, replaced by other cereals. Much of the oats, particularly in the north, and formerly in the Færoes, is cultivated for use as green fodder. Mixed grain, with or without a legume, is occasionally grown with oats as a basis: the yields are higher than if the grains are grown separately and the combination of grain and legume makes a more valuable fodder. Oilseed crops were greatly increased during the war to meet the needs of the margarine industry which could not be supplied from abroad.

Potatoes thrive best on dry sandy soils and, like rye, can be grown in soils so poor that most other crops are precluded. In the foothills on the south edge of the Småland plateau potatoes are grown until the soil is exhausted and then the land is left fallow. The only crop in Finland which gives a greater yield per acre than in Sweden is potatoes. Potatoes are grown in Iceland, east of Mývatn in the north, in almost pure sands which are naturally warmed by vapours rising as a result of vulcanicity. By subsidy and control of minimum prices and by introducing better varieties the Icelandic government have endeavoured to increase the production of potatoes but the harvest is still not sufficient to meet the requirements. All the other principal Scandinavian countries can grow sufficient to meet

their needs while in the case of Denmark there is an export of seed potatoes.

As fallowing declines as a practice so root-crop cultivation increases in the rotation. Sugar-beet has been grown in Sweden for a century and in Denmark for about three-quarters of a century and despite the labour difficulties associated with this exacting crop, these countries can produce most of their sugar requirements; but in Finland, where less suitable land is available, the demand cannot be met from sugar-beet. In Sweden, to encourage and to subsidise the home production of beet sugar, the State in 1932 granted a monopoly of sugar imports to two sugar companies and this at once resulted in an increase in the acreage of sugar-beet: under Swedish soil and climatic conditions in 1934 the yield was 15 tons per acre ($36\frac{1}{2}$ metric tons per hectare) of beet with a sugar content averaging 16·4 per cent. The yield and sugar content vary according to the weather of the growing season but it is claimed that Malmöhus province has the largest average yield per acre of beet sugar in the world. The sugar-beet is only grown within reach of refineries and the local transport network has frequently been improved to enlarge the supply of beet to the factories. For this same reason all the Swedish sugar refineries are in the south and the districts were supplied with a network of local railways to carry coal and lime, as well as the beet, to the refineries, but most now goes by road.

In the past, hay was obtained exclusively from natural grassland but now there is more interest in rotation grasses which secure not only a more nutritious hay but also have a greater yield. Timothy, which gives high yields on poor soils, has revolutionised Finnish pastures, for it can grow in peaty areas where clover will not thrive. Undoubtedly the key to much of the future well-being of northern agriculture is hay for it is the basis of keeping livestock during the long winters. Lucerne has been tried as a ley crop and, although desirable on account of its high protein content, it is not generally successful in Scandinavia as it needs a lime-rich soil and a dry climate. Drying the hay is also a problem, particularly in the districts with a maritime climate, and wires and poles are widely used to expose the grass to wind-drying. Hay production dominates Icelandic agricultural economy but even in Finland the largest crop by weight is hay, while Finnish cattle obtain nearly half their fodder supply by summer grazing in the pastures.

LIVESTOCK

Production based on domesticated animals is greater than that from arable farming and the cash income received is largely controlled by the animal products. The cessation, after 1875, of the large

export trade in grain from Denmark and southern Sweden meant that livestock were kept in greater numbers and this undoubtedly helped to restore soils which had deteriorated through excessive growing of wheat. The following totals for cattle and pigs, therefore, are much greater than at the period when grain was the staple product.

Livestock numbers in thousands, 1939 and 1960

		Denmark	*Finland*	*Norway*	*Sweden*
Cattle:	1939	3,326	1,767	1,455	2,986
	1960	3,394	1,922	1,129	2,501
Pigs:	1939	3,183	473	362	1,425
	1960	6,147	432	495	1,915
Sheep:	1939	147	923	1,744	353
	1960	44	341	1,862	156
Horses:	1939	594	342	204	633
	1960	171	251	108	209

(Based on *U.N. Statistical Yearbook, 1951*, Table 30, and F.A.O. *Production Yearbook, 1961*, Tables 69, 70, 72–3)

Cattle breeding has been for centuries an important feature of northern agriculture and to-day, apart from the pasture lands, the object of much of the arable farming is to produce fodder. This tends to limit livestock northwards as it becomes increasingly difficult to provide a supply of winter fodder. The most northerly dairy cattle in the world must be those kept under a rather artificial environment in Spitsbergen. When Danish dairy farming increased in the 1880s the number of milch cattle was increased but the number of beef cattle remained about the same and continued to meet the home demand. All these countries have crossed their native milch breeds with imported breeds, such as the Ayrshire. It is significant that dairy products supply a large proportion of the calorie intake so not only is dairying a mainstay of the export trade but is also a mainstay of subsistence.

Milk production, Pre- and Post-War
'000 metric tons

Denmark		*Finland*		*Norway*		*Sweden*	
1935–9	1960	1939	1960	1934–8	1960	1934–8	1960
5,270	5,399	2,574	3,494	1,360	1,690	4,596	3,926

(Based on *U.N. Statistical Yearbook, 1951*, Table 32, and F.A.O. *op cit.*, Table 83)

The milk output per beast more than doubled in the fifty years from 1880 to 1930 and the number and capacity of the co-operative and other creameries increased to absorb this larger output for butter and cheese manufacture. There is a considerable milk condensing and canning industry in Denmark, where the export of condensed milk represented in 1959 over five per cent of the value of the total industrial exports, and even in Iceland there is an industry sufficiently great to meet the home requirements. Strict control over the manufacture of butter for export has given these countries an asset in their sales to the industrial countries of Great Britain and Germany.

Butter and cheese production
'000 tons

		Denmark	*Finland*	*Iceland*	*Norway*	*Sweden*
Butter:	1931	195	28	?	6	54
	1938	189	61	0·5	24	97
	1946	141	13	?	6	100
	1960	167	93	1	18	84
Cheese:	1931	23	5	?	16	30
	1938	35	11	0·3	18	36
	1946	52	4	0·3	10	44
	1960	113	31	?	40	54

(Based on *U.N. Statistical Yearbook, 1951*, Tables 67, 68, and 73; *ibid., 1958*, Tables 68 and 69)

It is appropriate here to consider, although it is not essentially a product from local agriculture, the margarine output of the Scandinavian countries for, in order to make butter available for export, there is a considerable local consumption of margarine. Margarine is now manufactured in Denmark from vegetable oils and in Norway from whale oil but it was originally prepared by expressing tallow from cattle carcases.

Margarine production
'000 tons

	1931	*1938*	*1959*
Denmark	79·3	81·3	86·4
Finland	7·2	14·0	29·0
Iceland	1·0	1·4	2·2
Norway	47·8	54·7	91·0
Sweden	49·7	59·0	112·4

(Based on *U.N. Statistical Yearbook, 1951*, Table 73, and F.A.O. *op cit.*, Table 74)

Per capita consumption of butter and margarine
lb. per year (1 lb. = 0·45 kg.)

	Butter		*Margarine*	
	1938	*1950*	*1938*	*1950*
Denmark	18·3	10·6	47·4	31·1
Finland	21·7	26·9	8·4	8·5
Norway	12·5	8·0	40·9	45·4
Sweden	25·0	30·6	20·5	26·0
U.K.	24·8	16·8	8·7	16·7
Netherlands	12·0	5·7	16·0	37·4

(Based on Sir G. Heyworth, *The Place of Margarine in the Economics of Nutrition* (Unilever Ltd.), 1952, Table 3)

Since 1949 all the Scandinavian countries have increased their output and this has enabled Denmark and Norway to maintain exports of butter without a deficiency of fats in the home market. The margarine industry is not the enemy of the dairying industry for it frees milk for the more profitable liquid milk and cheese trades, while the fat yield from an acre of soya beans is about three times that of the best land used for dairying.

Connected with dairy farming is pig breeding which uses the by-products of the creameries. Before 1895 much of the pig-products went to Germany but since then Denmark, in particular, has specialised on the British market and has bred pigs to meet the British demand for a lean bacon. Finland and Norway have joined Denmark and Sweden in meeting the demands of the British market. The by-products of bacon production (offal, lard, etc.) still go to Germany. The production of bacon is also in the hands of co-operative factories which fix standards and prices.

Sheep numbers are not so great in the Scandinavian countries as might be expected, for a number of factors hinder sheep-rearing factors which include housing and feeding during the long winters, the prevalence in some districts of beasts of prey and the reclamation of much rough grazing for forestry and farmland. This means that the production of wool is insufficient to support the woollen textile industry and wool imports are required. Only in Iceland and the Færoes is there, proportionally to the population (see Table on p. 315), a considerable number of sheep but the stock, although hardy, is of the small Norwegian breed. From Iceland there is a surplus of mutton for export and in 1930 a refrigeration plant was established to do away with the salting of the carcases. Elsewhere

in Scandinavia, other than in the Færoes, the sheep have been improved by selective breeding and crossing; for over two centuries experiments have been carried on with merino sheep to get finer and heavier fleeces.

Horses are still bred, although the use of tractors and of motors has tended to displace the need for their power in Scandinavia. So long as the holdings remain small and the patches of arable tiny, the horse will be more valuable than the internal combustion engine but foreign

A.C.O.] [*August, 1938*

FIG. 137.—NEAR AKUREYRI, ICELAND.

This is a farm at a pig-breeding station. The wetness of the land is shown by the deep open drain which has been cut.

markets have been lost to mechanisation—no longer is the Icelandic pony bred for use in British coal-pits and the sales of the strong Jylland horse in Germany have almost dwindled away. In Iceland, although the export trade has declined, there are still considerable numbers of horses for they are used for transport in roadless areas as well as on the holdings. After the decline of the grain trade Denmark and Sweden turned, *inter alia*, to poultry-keeping to consume the grain, the main interest being egg production. Over one-quarter of the world trade in eggs is supplied by the northern countries.

One traditional item of livestock has been the reindeer of the

Lapps and consideration of this activity is given on p. 126. A new activity is silver-fox farming which developed first in Norway and was adopted in 1927 in Sweden and then, from 1930, in Finland. By the outbreak of war there were over half a million furred animals kept in Norway of which four-fifths were silver fox and mink, but nutria and blue fox were also important. With the decline in prices in recent years fur-farming has been less important in all the Scandinavian countries.

Fur-animals in Norway, '000

	June, 1939	*September, 1946*
Silver fox	493	217
Platinum fox	5	13
Blue fox	29	107
Other fox	1	0·7
Mink	26	39
Skunk	0·4	—
Other animals	0·3	0·02

(Based on *Statistisk Årbok for Norge*, 65–7 Årgang, Oslo, 1948, Table 60)

AGRICULTURAL HOLDINGS AND TECHNIQUES

The land is still characteristically divided into small farms owned by peasants. The percentage of owner-occupiers ranges from 94 in Denmark to 60 in Iceland, although the basis has turned from "subsistence farming" to "cash cropping". In this northern environment the small peasant holdings of under 24·7 acres (10 ha.) now exceed three-quarters of the total number of farms and there is often too narrow a margin for a satisfactory living and so a certain amount of land-hunger exists. In order to relieve this land-hunger in Finland and Sweden colonisation of the forest lands has taken place since the beginning of this century, while in Denmark there has been much reclamation of waste land. In Denmark, although over half the holdings are under 24·7 acres (10 ha.), there are more larger units than in other Scandinavian countries, largely because the smoother relief permits larger agglomerations of tilled land; this is fortunate because the Danish farmer has not the forest wealth which is so often attached to the holding of his Norwegian, Finnish or Swedish counterpart, or the large areas of grazing available to many Norwegians and Icelanders. In Iceland and in the coastal belt of Norway the agriculturalists also obtain a supplementary livelihood from fishing. Except in Denmark and in parts of southern Sweden and Norway the natural conditions prohibit large arable fields and

Average size of agricultural holdings

Denmark	38 acres	15 ha.	
Finland	20	8	
Iceland	1,359	550	(of which 6½% cultivated and meadow)
Norway	8½	3½	(cultivated and meadow)
Sweden	22	9	(arable and grass)

the northern countries must remain lands of small farms with supplementary sources of income.

Only towards the end of last century were the considerable advances made in agricultural techniques which turned farming from primarily a subsistence economy to "cash-cropping":[1] these advances were made possible by education, agricultural research, co-operation and by the use of appliances such as the cream separator. Before these changes there had been sales from the farms to foreign markets. Grain from Denmark and Sweden, for example, was sold in the seventeenth century in Portuguese markets, a return cargo of salt for fish and meat curing being purchased with the proceeds. After the Industrial Revolution and the repeal of the English Corn Laws in 1846, grain was exported to Britain. These markets closed dramatically with the opening of the American temperate grasslands and the farmers were forced to turn to livestock, a transfer which was accelerated by the modern need to produce a cash income from the farms as self-sufficiency declined.

Co-operation has been a hallmark of Scandinavian agriculture for three-quarters of a century; starting with creameries in Denmark, the first co-operative butter unit was that which Hjeding founded in 1882; the system was later applied to bacon factories as well as to the purchase of feeding stuffs and fertilisers. Denmark was the home of this type of voluntary organisation, which has reduced the need for aid and interference by the State except in periods of acute economic distress. In Finland co-operation is of later growth, having been established in 1905, and to the work of these associations much of the agricultural progress of this century is due. Similar associations exist in Sweden together with an agricultural bank and these organisations are federated together and jointly handle most of the farm produce. In Norway co-operative societies handle much of the dairy and other produce; in Verdal, for example, the economy of the valley depends upon the society. Iceland also has a strong co-operative movement which dominates the export of agricultural produce and trades with the Scandinavian Co-operative Wholesale Society.

[1] "Cash-cropping" is here taken to include products from farm livestock.

STATE CONTROLS

Under the economic blizzard of the early 1930s the governments of the Scandinavian countries, anxious to assist such a basic industry as agriculture, passed various measures giving subsidies and other privileges. It would be tedious to detail all these but the more important measures adopted in Sweden may be given to illustrate the range and scale of these controls in the decade before war.

Grain

1930: Swedish flour had to be mixed with all imported wheat and rye flours. Government loans to assist co-operative associations of farmers to store grain and to secure advances before crop sold.

1931: Association of millers formed which was given monopoly of all grain imports and in return agreed to purchase at fixed prices all unsold stocks of Swedish grain.

1935: Good harvest of 1932–4 resulted in over-production of wheat and in 1935, to discourage this, there was a levy of 1 öre per kg. of wheat.

1935: Swedish Cereals Co. (State-owned) to buy all Swedish grown wheat and rye and any loss to be borne by a tax on imports, but 1938 harvest was 11 per cent above 1931–5 average harvests and no export possible so wheat prices fell.

Sugar-Beet

1930–1: Subsidy to beet growers.

1932: Monopoly to two Swedish sugar manufacturing companies which in return agreed to pay 2·30 kr. per 100 kg. of standard beet to growers. (In 1936 these companies amalgamated and so monopoly of sugar refining and wholesale distribution of sugar in Sweden.)

Milk

1933: Levy on milk, administered by National Association of Swedish Dairies, to maintain prices of butter and milk on home markets. (Led to over-production of butter.)

1936: Tendency for milk prices to rise so levy reduced.

Meat

1934–5: No imports of meat, except dry-salted American pork, allowed from October, 1934, and only limited quantities of fresh meat allowed from Finland and Estonia.

Eggs

1934: From February, 1934, no eggs allowed to be imported without licence and any excess profits of egg export to be used to subsidise egg prices on home market.

General

1934–5: Agricultural Price Regulation Fund with principle of levying special duties on agricultural products and cost to fall on those concerned, e.g. import duty on oats, maize and other feeding stuffs to fall on producers of meat and eggs.

INDUSTRIES BASED ON AGRICULTURAL PRODUCTS

Dairying gives rise to important manufactures of which butter and cheese have been examined above. Less in quantity but still valuable are the by-products of casein and rennet. Denmark also makes bio-chemical products such as insulin and hormones, which preparations were based originally on her slaughter-houses, and to these have been added pharmaceutical products such as penicillin. Bacon processing is a valuable item in Denmark and is also considerable in Sweden.

Food and drink prepared by processing home-produced agricultural items are important in Scandinavia. Milling of wheat is practised on a considerable scale in Sweden, Denmark, Norway and Finland and in the last three countries, and most of all in Finland, there has been a great increase since 1931 in the quantity of flour produced: part of this increase is due to having a higher extraction rate. Beet sugar is produced in Denmark and Sweden and in both countries the post-war output, at about a third of a million tons, has been between two and three times that of 1931 when self-sufficiency was not so important.

Various drinks are produced, particularly beer and spirits. For the beer, locally malted barley is used while spirits are distilled from malt and from potatoes. Denmark produces more beer than any of the other Scandinavian countries but it is much less than that of Belgium or Ireland. Besides supplying a raw material for distilleries, potatoes are also used for the manufacture of starch and yeast.

Leather and fur preparation are traditional activities in the north, and Finland used to be one of the greatest leather centres in Europe. To reduce leather imports since the war the Finnish Government has encouraged the import of hides and considerable quantities of hides and skins are imported from South America: this is necessary as home supplies are too limited. The Danish output of hides is much greater than the domestic requirements for leather but sheep and goat skins are imported. There are many tanneries in Norway but they are largely dependent upon imported hides.

CHAPTER 16

FORESTRY AND WOOD-USING INDUSTRIES

The three countries of Finland, Sweden and Norway contain about one-quarter of the forested area of Europe and possess 56 per cent of the coniferous forest wealth of Europe (excluding the Soviet forests, the timber from which does not enter world trade on account of unfavourable transport facilities and political obstacles). Finland has the greatest volume of growing timber, per head of population, of any European country—10,770 cu. ft. (305 cu. m.)—while Sweden is second with 8,190 cu. ft. (232 cu. m.) and Norway has 4,000 cu. ft. (113 cu. m.); moreover, as regards annual timber growth, also expressed per head of population, these three countries are again first, second and third respectively on the European list. This wealth is due to the fact that so much of their area lies within the coniferous belt of the northern hemisphere. The corresponding belt in eastern North America is considerably farther south; the forest growth of Maine in latitude 45° N. is equivalent to that of central Sweden in latitude 60° N., for the climate of the latter is moderated by the North Atlantic Drift. With the considerable latitudinal extent of Scandinavia there are great differences in forest types, beech and oak being progressively eliminated northwards. The high altitude and latitude of the north and the existence of the high watershed between Norway and Sweden produce severe winters and a very short growing season so even the hardy spruce and pine cannot reach the shores of the Arctic Ocean. The July isotherm of 50° F. (10° C.) approximates to the northern limit of these conifers. In southern Finland the annual growth is about $11\frac{3}{4}$-$16\frac{1}{2}$ cu. ft. per acre (2·5–3·5 cu. m. per ha.) whereas in the north it is only about $4\frac{3}{4}$ cu. ft. (1 cu. m.), but not all this difference can be attributed directly to climate since the soils, which are of course influenced by climate, are poorer also. While the tree growth is slower and the tree size smaller in the more rigorous north this is compensated for by the greater durability of the timber. In the south of Fenno-Scandia the timber is formed more freely but is lighter and less durable although, in its turn, it is better than the timber from Central Europe.

If the average temperatures of northern Sweden be compared with the mean temperatures for the same latitudes in Russia and Siberia it is found that the winter temperature of Sweden is higher and the summer one lower, while in Russia and Siberia the insolation received

is greater for there is less cloud—another sign of greater continentality. As a result, although the subsoil may be permanently frozen, trees grow farther north in Siberia than in Scandinavia. Finland,

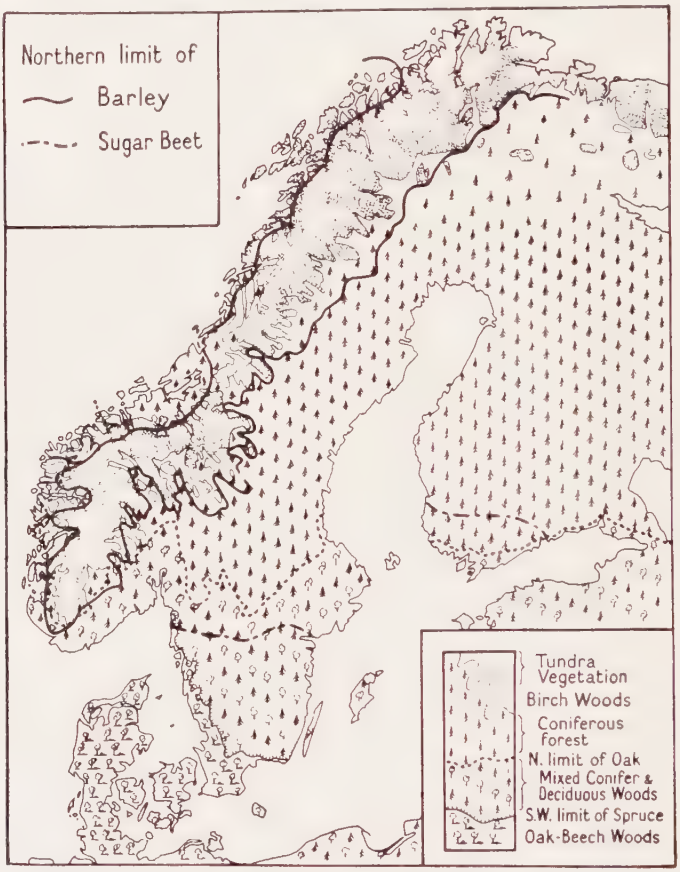


FIG. 138.—TREE AND CROP LIMITS.

This map, based on various authorities, shows the progressive reduction northwards of deciduous and coniferous trees and of crops and also clearly reveals the significance of the high land of Scandinavia in limiting crop and tree growth.

being somewhat less affected by the ocean, provides a better environment for spruce and pine than Sweden. If it is assumed that tree growth takes place when the mean daily temperature exceeds 43°F. (6°C.) then in northern Sweden about 100 days at this temperature are available for forest growth. Micro-climates become of significance in Sweden and Norway, and to a lesser extent in the less severe

terrain of Finland, on account of temperature inversions, while west and south slopes, which receive more insolation, are warmer than east and north, but greater evaporation may make these warmer soil areas yield less in tree growth. Again, where there is a large mass of highland, and the mean level above the sea is high, trees grow higher up the slopes than on the flanks of isolated peaks: this is referred to as "the effect of mass elevations". Precipitation as well as temperature affects tree growth and it is fortunate that, over much of Scandinavia, most falls during the summer when evaporation is at its greatest while the snow-melt helps to saturate the ground with desirable moisture. If de Martonne's humidity coefficient (mean annual rainfall ÷ mean annual temperature + 10) be calculated for Scandinavia it is seen that, because of lower temperatures, the northern territories are well favoured for tree growth. While temperatures decrease with altitude, rainfall increases in an area exposed to Atlantic air by as much as 7·9 in. (20 cm.) each 328 ft. (100 m.), and this makes tree growth slower, as the soil becomes dark with raw humus.

The Scandinavian countries have an areal extent and climatic and soil variations sufficient to produce several different forest types and the characteristics of these are here summarised:

Beech Region: This differs from the other types, except the Alpine Birch, in that hardwoods predominate and spruce is absent in natural stands. The beech occupies more fertile soils and the areas with a more moderate climate in Denmark and Sweden—it only just reaches Norway—and hence appears as isolated woods against a pattern of farmlands. Within the region plantations of *Pinus montana* and spruce have been made in order to reclaim dune and heathlands; in Denmark these reclamations represent over 60 per cent of the wooded area.

Southern Coniferous Region: Although this region is dominated by conifers, the oak occurs but is not abundant, for *Quercus pedunculata* and *Q. sessiflora* are only frequent on the more fertile soils and in the coastal districts. Beech (*Fagus silvatica*) and ash (*Fraxinus excelsior*) also appear as part of the second growth after forest clearance. This region has long been settled and much of the forest has been removed for building and fuel and, in Norway, for shipbuilding also.

Northern Coniferous Region: Scots pine (*Pinus silvestris*) and Norway Spruce (*Picea excelsa*) predominate with birch (*Betula verrucosa* and *B. pubescens*) and, in the most favoured localities of the south, elm (*Ulmus montana*), maple (*Acer platanoides*) and lime (*Tilia parvifolia*). In Finland 55 per cent of the forest trees are pine, 30 per cent spruce and 14 per cent birch. The spruce entered Scandinavia after the pine and is now tending to displace it, being

able to flourish in shady areas; this is a reversal of what was happening when forests were cleared by burning for occasional cropping, or as a result of accidental forest fires. Little land has been reclaimed

A.C.O.] [*September, 1953*

FIG. 139.—UPPER LIMIT OF TREE GROWTH (ABOUT 2,000 FT.), EAST OF BERGEN.

for farming in this broad rolling terrain but there are still large areas of swamp and bog which break the continuity of the forest cover. The timber is readily accessible and so is exploited on a large scale.

Alpine Birch Region: This forms a transition belt between the coniferous forests and the mountain barrens. The lower limit is some 3,200 ft. (975 m.) in eastern Norway and Dalarna, 1,700 ft. (520 m.) in Lapland, 1,000 ft. (305 m.) in Finmark and near sea-level in Iceland. The main trees are the crooked birch (*Betula tortuosa*), grey alder (*Alnus incana*), aspen (*Populus tremula*) and various species of willows. In Iceland the forests consist of dwarf willows, mountain ash (*Sorbus aucuparia*) and dwarf birch species (*Betula odorata* and *B. nana*). The only use made of this growth is by the nomadic Lapps for fuel and hut timbers and by the Icelanders for fuel and fodder.

After the retreat of the ice-sheet the forest-cover reappeared and the composition of these forests was primarily controlled by the prevailing climate, but not exclusively so, and other factors came into play to create an exceedingly complicated pattern. During the Ice Age the various species persisted in different areas of refuge. If the subsequent rate of migration were the same, trees from the more remote centres of refuge would be later in re-colonising their former territories; however, some trees spread more slowly than others and so they would be handicapped by coming into an environment already occupied by forest instead of into a grassland area. Again, local conditions affect the type of tree which can flourish: clay soils favour deciduous trees, sandy soils pine, and where the ground has a high water-table alder flourishes. The study of forest-composition in the past has been greatly aided by pollen-analysis, a technique which originated in Sweden.

Trees require soil to maintain them, and at the same time they affect the character of the soil. They demand a higher precipitation or more ground water than do grasses, and the best source seems to be moving ground water which brings salts and oxygen to the roots. For full growth a tree requires mineral salts, which may be needed in minute but vital trace quantities. Of the needle-trees, pine makes the least demands on the soil and spruce the most, while of the more exacting broadleafed trees birch and aspen require least from the soil.

In this century, following pioneer work in Finland by A. K. Cajander, the northern forests have been classified not merely by the trees but also by the low growing plants, which reflect the soil conditions. The modern classification, with further subdivision into minor varieties, is as follows:

Lichen-rich forests
Moss-rich forests
Dryopteris forests
Herb-rich forests
Swamp forests.

Where the water table is high sphagnum mosses occur.

Soils consist of organic materials and minerals and the latter may be an inert mineral, such as silica, or a soluble substance, such as apatite or calcite, which dissolve and give valuable nutriment to the tree. The clay particles (under 0·00008 in., 0·002 mm. diameter particles) and silts (0·00008–0·0008 in., 0·002–0·02 mm. diameter) are significant in a soil as they affect its water-holding capacity and as these clays are richest in the fine-grained constituent minerals they are frequently very fertile. However, the water-holding capacity of clays can be greatly reduced by their tendency to crack in dry seasons. Granites and diorites weather to material rich in plant-sustaining constitutents and the outcrop of these, and of moraines derived from them, can be seen in the more productive forests formed; but organic humus, as well as the thickness of the soil, may modify the generalised pattern.

Withered needles and leaves add considerably to the minerals in the soil and if the subsoil is rich in soluble salts this is reflected in the composition of the litter. Different species of trees also add different proportions of minerals in the litter and there is a considerable return of the valuable materials which the roots take up in excess of requirements.

Amounts of litter and some components in a year, lb. per acre (kg. per ha.)

Tree	*Location*	*Age, years*	*Litter dried*	*Nitrogen* N	*Lime* CaO	*Potash* K_2O	*Phosphoric Acid* P_2O_5
Aspen .	near Stockholm	—	1,615 (1,810)	9 (11)	54 (60)	16 (18)	2 (2)
Birch .	Veldre, Norway	50	1,674 (1,876)	18 (20)	36 (40	5 (6)	3 (3)
Pine, alpine	Hirkjölen, Norway	200	713 (797)	5 (6)	5 (6)	0·7 (0·8)	0·8 (0·9)
Spruce .	near Stockholm	90	2,756 (3,089)	27 (30)	57 (64)	13 (14)	4 (5)
Spruce, alpine	Hirkjölen, Norway	140	1,307 (1,465)	12 (13)	22 (24)	3 (3)	2 (3)

(Based on Tamm ,p. 75)

Owing to this annual fall of litter the top layers of a forest soil are always rich in humus: where there is a granular structure it is termed *muld* (mull), where it is fibrous *maar* (mor) and where it is formed under stagnant water *peat.*

Under the relatively cold conditions of Scandinavia soils form slowly, for bacteriological activity is slow, while lime tends to be lost

by leaching—thus giving poor soils of the *podsol* type with a bleached layer below the humus top cover and above an iron-stained layer or a hardpan. In Finland leaching occurs everywhere but is particularly serious in the north where lime is least. Where there are clay soils water cannot percolate so readily and leaching is reduced so that a grey soil is produced. Where the ground water is near the surface and the subsoil is rich in sulphates occur the so called sub-soils; these are developed in Ostrobothnia, where they derive their sulphates from Littorina clays. The agricultural technique of *burn-beating* land alters the soil content, and the modification is perceptible generations later. In the south of Scandinavia the higher temperatures encourage the formation of brown soils particularly in the lands of deciduous woods, and these grade northward into the podsol zone where patches of brown soil occur only rarely. Brown soil is also found in limited areas in southern Finland.

Silviculture is much advanced in these countries, but even in Finland only 15 per cent of the forests are regarded as receiving excellent treatment. The reproduction of the forests is secured by leaving seed trees instead of replanting as in Britain: this natural regeneration is said to produce hardier trees which are not so vulnerable to insect and fungus damage. In the 1930s the Finnish Forestry Board encouraged the growth of spruce on areas of better soil, in order to increase the raw material available for the paper industry. Most of the planting which is done is in Denmark and southern Sweden. Unfortunately the rigorous climatic conditions prevent trees from seeding well in the north every year and good years perhaps come only once in ten years. The natural regrowth of the forest cover is also handicapped northwards by the reduced areas of suitable soil. Many fears have been expressed that the annual cut is more than the annual growth, and these fears resulted in the making of detailed forest surveys in the three principal countries, the first being in Finland in the early 1920s. It is desirable in good forestry technique to equate the growth and cut, for overcutting is obviously timber "mining", while undercutting also leads to wastage, although not so dramatically, through timber passing its prime. The abandonment early in this century of the practice of burn-beating together with the decreased loss by accidental forest fires in Finland have helped to compensate for the greatly increased felling-rate. In Finland it has been estimated that ninety to ninety-five per cent of the annual growth is cut while in Sweden and Norway the depletion is about five per cent below the annual growth. The present annual increment is estimated at 70 million metric tons dry weight (140 million cu. m.), that is equivalent to about 15 million standards of sawn timber or 28 million tons of chemical wood pulp.

The yields of timber are increasing with improvements to the forest lands, for example, by draining, and this process was accelerated by the governments' schemes to ease unemployment during the economic depression about 1930. Yields are also affected by climatic variations. There is a great desire for improvement for three-quarters of the world's timber consumption is coniferous wood and only one-third of the world's forests are coniferous; thus any preservation of forests is likely to become an improving asset as the consumption outstrips the supply generally and other centres cease to supply to the world markets.

Statistics of Exploitable Forest Lands
c. 1960

	Finland	*Sweden*	*Norway*	*Denmark*
Area:				
Million acres	26·6	55·6	17·3	1·1
Million ha.	10·8	22·5	7·0	0·44
Percentage of Land Area	64	51	22	10
Per Head of Population:				
acres	12·4	7·7	3·7	0·2
ha.	5·0	3·1	1·7	0·1
Standing Timber:				
Million cu. m.				
Pine	653	740	90	
Spruce	533	826	171	
Other trees	307	277	62	
Annual Rate of Growth:				
Million cub. m.	44·4	47·7	13·0	2
of which coniferous percentage	72	80	83	
Growth:				
Cu. m. per ha.	2·2	2·3	2·2	4·8
Annual Felling:				
Million cu. m.	42·3	46·0	11·0	1·8

One cubic metre equals 35·3 cubic feet.
(Based on statistical yearbooks)

Forest ownership has played its part in the development of the resources; the State holdings are chiefly in the remote north and on watersheds and so tend to be formed of old-age trees while private holdings are near the more densely settled areas and so, having been long exploited, are made up of younger stock. The forests owned by industrial corporations are normally outside the populated districts. The present ownership of the forests in Sweden and Finland was

Forest Ownership

	State	*Communities and parishes*	*Corporations*	*Private*
	%	%	%	%
Finland .	34·2	1·8	6·8*	57·2
Sweden .	18·5	5·8	25·3	50·4
Norway .	13·2	7·4	8·4	71·0

* The State has a majority share in one-third of these companies.

affected by Gustav Vasa, who decreed in 1542 that all waste land, including forests, was to become Crown property. The active colonisation policy by the Swedish government of the day had to avoid the areas where timber was used as charcoal in iron smelting. In Sweden at the beginning of the nineteenth century, Crown forests were sold to companies, particularly the ironworks, which needed the timber, and it was only after 1850 that the State began to realise the value of conservation of its forest lands and since then has purchased forest lands. It was the remoteness of the northern forests in Norway and Finland which protected them from unthinking exploitation in the nineteenth century. Since 1909 in Norway it has been illegal for foreigners and companies, or even individuals, to acquire large holdings of forests. The State forests of Finland are mainly in the north and east, those of Sweden and Norway in the north; that is, in the areas which offered least opportunity for early development. The forests owned by the farmers tend to be overcut and to be damaged by grazing, or else are not worked at all in a misguided attempt at conservation. Norway, in particular, has sometimes experienced difficulty in getting the supply of timber required to maintain the output of her timber-using industries. Three-quarters of her forests are owned by farmers who, in the 1930s for example, preferred to allow the timber to grow rather than to sell at the prevailing low prices.

Forestry is a considerable source of employment and in some districts is a major element of the economy; for example, every other man in northern Sweden, between the ages of 18 and 65, works in the woods for at least part of the winter. Of the selling price of the exported timber and pulp 22 per cent represents labour costs in the forest work of felling and floating. As a measure of the demands on labour, the cutting and hauling of wood for sale in Finland in the logging season of 1946–7 consumed 30 million man-days and 10 million horse-days. In Sweden only about seven per cent of the forest labour is devoted to maintaining the timber supply but the demands for this purpose are unevenly distributed, for in the south

four times as much labour is required as in the north where there is more natural regeneration of the stands. So important is the need to keep the population of the forests employed that the State was forced to buy and maintain bankrupt sawmills during the market depression of the early 1930s.

In the northern countries forestry is closely related to agriculture and most farmers get a proportion of their income from the sale of surplus timber as well as obtaining fuel; the proportion of the income derived from timber sales increases northwards. Some farmers also fell and drive logs in winter for the large producers and thereby earn a valuable supplementary income which usually exceeds anything they can get from the sale of their own timber. While the reclamation of land from forests for agriculture is going on continuously, it is more than balanced by the reclamation of wet tracts for forest growth. In Norway the development of seters has depleted mountain forests while the long settlement of the coastal zone has left it locally bare of timber. Since the war there has been a labour shortage in Norway for felling and transporting timber, as well as for afforestation works, and the post-war cut has not equalled that of the pre-war period.

One of the great problems of the lumber industry is transport, for this makes up much of the cost to the consumer. Nature has aided the Fenno-Scandian countries by providing many rivers, which differ from those of Siberia in that they flow towards the more populated districts. Further, they flow southwards across the timbered territory so that the mouth thaws before the upper reaches and, with the limited flooding which results, the logs do not have to be rafted together. For a distance of about five miles (8 km.) it is economic to haul by horse-sleigh over the snow: motor trucks can carry more but the passage is more difficult unless roads have been provided. The importance of river transport is seen from the example of Sweden, where each year about 1,406 million cu. ft. ($11\frac{1}{2}$ million cu. m.) of wood is floated down to the mills at one-seventh of the cost of rail transport. The fast flowing streams of northern Sweden allow the logs to travel to the mills in one season which reduces the loss by water-logging. Norway, with its many waterfalls, and Finland, with its many quiet lakes, do not have a river regime so suitable for floating but the mileages used for this purpose are all considerable: Norway 9,375 miles (15,000 km.), Sweden 20,379 miles (32,546 km.) and Finland 8,000 miles (14,100 km.). To facilitate timber-floating, bends have been straightened to reduce the risk of log jams while flumes have been made to by-pass the rapids, and these are now being reconstructed in concrete. The big waterways are worked by timber-floating associations and the logs are passed downstream, irrespective

of ownership, as rapidly as possible. At the sorting ponds the logs are grouped by owners' brands and then rafted to the mills which are occasionally many miles along the coast. In southern Sweden the

A.C.O.] [*June, 1932*

FIG. 140.—TIMBER FLUME BY-PASSING WATERFALL NEAR TRONDHEIM.

rivers are not so fitted for floating and railways are used to a greater extent to feed the saw mills. The absence of large forests in the south results also in the small size of sawmills and there is a greater interest in joinery.

WOOD-USING INDUSTRIES

To-day the stage of development of timber utilisation in the various Scandinavian countries varies. Norway has passed the sawmill stage and concentrates upon higher value working, whereas in Finland the centre of interest of the wood-using industries is balanced between sawn timber and semi-manufactures; in the Swedish industries there is more working-up of the timber than in Finland.

Denmark possesses a wood-using industry but depends upon imported raw materials and on Danish beech.

In the northern countries the timber is produced for a variety of purposes. Various estimates have been made of the consumption in the main categories and average statistics are given in the following table.

Consumption in million cu. ft. (million cu. m.)

	Home fuel	*Sawmills*	*Paper pulp*	*Unworked timber*	*Charcoal*	*Railways*
Finland .	529 (15)	423 (12)	247 (7)	106 (3)	—	35 (1)
Sweden. .	388 (11)	423 (12)	423 (12)	—	70 (2)	—
Norway .	106 (3)	70 (2)	141 (4)	—	—	—

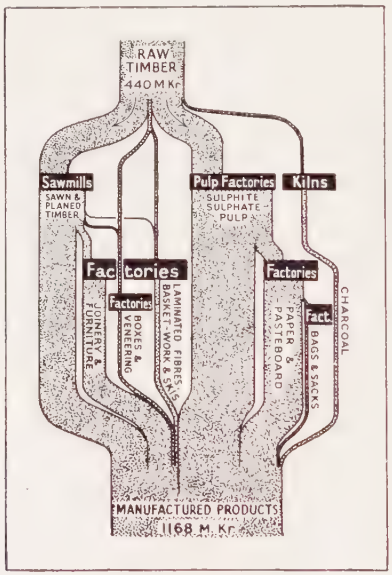


FIG. 141.—VALUES ADDED BY TIMBER-PROCESSING.

As the northern countries became more industrialised their timber resources, despite the cutting of the larger and more accessible stands, became more valuable as is shown by the values added to the Swedish cut timber in 1937.

Based, by permission, on *Sveriges Industri*, Stockholm, 1948, p. 367.

The earliest records show that forest produce was exported as baulks, masts and tar for shipbuilding. Even as late as the seventeenth and eighteenth centuries tar was the chief export and exceeded the lumber exports in value. Water-driven sawmills were introduced at the end of the fifteenth century and Norway, with many falls and abundant ice-free harbours, became a leading exporter of sawn timber while the neighbouring countries exported much less, as a result of legislative restriction through fear of excessive exploitation. The forests of Sweden tended to be dedicated by the Crown to the production of charcoal until the eighteenth century. This was not altogether a harmful restriction for it resulted in the evolution of sound forestry technique in the chief mining district of Bergslagen; it was essential to

preserve the source of charcoal without which the mineral wealth was valueless. Gradually the restrictive practices were abandoned in both Sweden and Finland. The first steam sawmills were permitted in 1849 in Sweden and the resultant increase in the size of the mills, together with the abolition of timber import duties in France (1865) and Britain (1866) forced a boom in the wood trade. The use of steam power, based on waste wood fuel, meant that the sawmills could be placed at the mouths of floatable rivers, instead of at the falls, and this resulted in the growth of a thriving sawn timber

FIG. 142.—SAWMILLS IN SCANDINAVIA.

One dot represents one mill centre; there is in addition an isolated sawmill at Jakobsnes near Kirkenes.

Based on maps and information in *Atlas of Finland*, 1925, *Handbook of the northern wood industries*, 1934, *Sveriges Industri*, 1948, etc.

industry along the shores of the Gulfs of Bothnia and Finland. Norway, unable to compete against her more richly endowed neighbours, lost first place amongst the sawn timber producers of the northern countries. Finland, where the production of sawn timber long continued, still headed the list of exporters in 1936.

The northern pine has a trunk of considerable length and without branches, and this renders the timber invaluable for carpentry. The size of sawn timber is less in the Scandinavian countries than in North America, for logs rarely exceed 8 in. (18 cm.) in diameter at

the small end; only about fifteen per cent of the lumber cut in Sweden exceeds this size. But this incapacity to produce large-dimension timber is not serious to-day for steel and reinforced concrete have taken the place of large section timber. In recent years the quantities of sawn timber produced have not greatly increased, but values have increased since much of the raw material is now planed and semi-manufactured. In an endeavour to reduce costs portable circular saws have been introduced in the felling areas but these are not so accurate in cutting as is the gang-saw used in the mills and lower prices are received, so that the advantage is doubtful.

A.C.O.] [*July, 1932*

FIG. 143.—PITPROPS AWAITING TRANSPORT ON THE GÖTA CANAL.

Until paper was first made in 1844 in Germany by the mechanical crushing of wood the paper trade was restricted by the limited supply of rags. Mechanically produced paper pulp was not found to be completely satisfactory. However, in 1853 patents were taken out, independently in both the United States and Britain, for boiling wood chips with a soda lye to produce sulphate cellulose; this new pulp, when mixed with mechanical pulp, proved to be excellent for paper manufacture. The first mill was established in Sweden in 1871; in the same year a Swedish chemist commercially produced sulphite pulp by boiling wood chips with calcium bisulphite. The sulphate pulp, made with resinous pine, produces strong papers of a brownish colour whereas the bleached sulphite paper is whiter and finer. Although mechanical pulp is the basis of newsprint, and therefore in great demand, there is a growing tendency in Sweden for

the more expensive chemical pulp to be produced from small timber. There is a third method of manufacture, known as the soda process, for converting aspen and other hardwoods to pulp but the supply of aspen wood is almost fully needed in Fenno-Scandia by the match industry and for wood wool, and any surplus can be used by the plywood industry. Mechanical pulp is exported wet, that is with 40–50 per cent moisture, and chemical pulp dry with only 10 per cent moisture to avoid mildew and to reduce transport charges. The centre of the preparation of pulp is in the Sundsvall area because

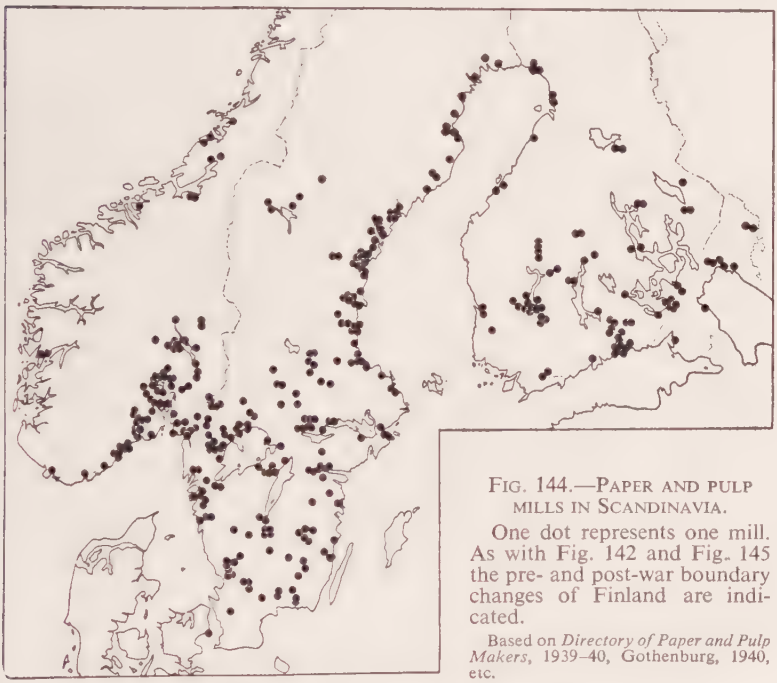


FIG. 144.—PAPER AND PULP MILLS IN SCANDINAVIA.

One dot represents one mill. As with Fig. 142 and Fig. 145 the pre- and post-war boundary changes of Finland are indicated.

Based on *Directory of Paper and Pulp Makers*, 1939–40, Gothenburg, 1940, etc.

here converge the most important "floating" rivers. Machinery for pulp manufacture in Sweden is mostly of local origin, but basalt millstones are imported from the Rhine area and rollers are turned in Aberdeen from Swedish granite. The paper produced consumes an enormous quantity of timber, since each ton of paper from chemical pulp needs about 200 cu. ft. (6 cu. m.) of wood; mechanical pulp is not so extravagant in timber requirements.

Since the boom in the pulp industries in the '70s and '80s the only setbacks have been due to war and its aftermath and now the weight

of chemical pulp produced in Scandinavia is over one-sixth of the world tonnage and of the mechanical, one-eighth. Some of the pulp is converted to paper in Scandinavia, and unlike the pulp mills, which are near their main source of supply in the northern coniferous region, the Swedish paper mills are farther south where the harbours are ice free and shipments can take place all the year round. Before the Second World War Canada, Sweden and Finland were, in that order, the greatest exporters of the products of the paper industry. Even in Norway, though the absolute production is smaller, pulp

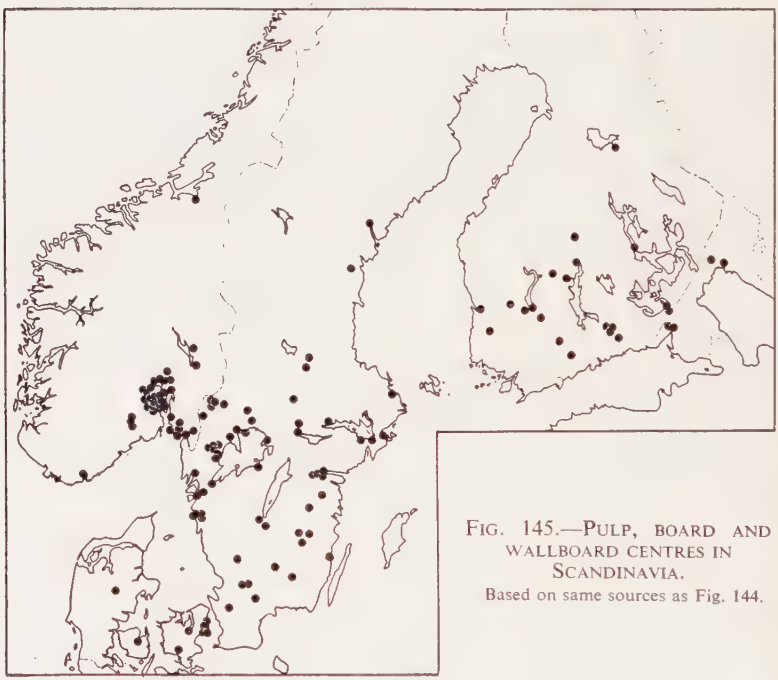


FIG. 145.—PULP, BOARD AND WALLBOARD CENTRES IN SCANDINAVIA.
Based on same sources as Fig. 144.

and paper provide nearly one-quarter of the value of the exports and provide a valuable source of income in otherwise non-industrial districts.

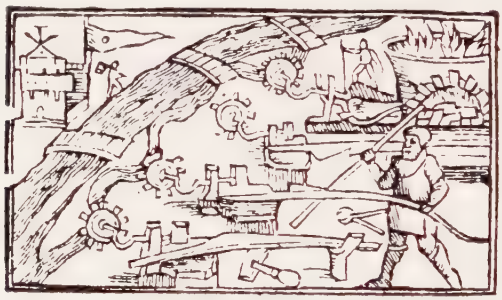
The birchwoods of Finland and Norway have been used for the manufacture of plywood. In the former country the birch is also used for spools and bobbins; Finland makes about 18 per cent of the plywood, over 50 per cent of the spools and 80 per cent of the bobbins entering international trade. The most valuable furniture wood of northern Scandinavia is the expensive curly birch. The plywood

industry of Sweden was started almost simultaneously with that of Finland, for the first factory was built near Söderhamn in 1913 for making hot-glued birch plywood but the Swedish industry, unlike the Finnish, did not develop much at that time, largely because of a shortage of suitable birch woods. Not until a cold-glue process was adopted could a pine-plywood be made and then production rose rapidly, with producing centres at Söderhamn, Härnösand and Kristinehamn. Unfortunately the southern pine is knotty but the wider annual growth rings give a more attractive figure to the plywood than the close-grained, slow-growing northern pines. Plywood has been used extensively in house construction as it is more economical of timber and does not shrink with central heating.

The variety of other timber products is increasing. The chemical pulp industry is expanding along new lines and besides producing artificial silk and wool, cellophane, celluloid, collodion and cellulose lacquer, it provides by-products such as sulphite and methyl alcohol, fodder yeast, turpentine, tanning extract, lignin for plastics, rosin and soft soap: these actitivies account for the greatly increased demand for pulping timber. The waste from the saw mills, formerly burnt, is also being used more profitably for the manufacture of wallboards. Originally the sawmills burnt the small timber, though sometimes the heat was used for steam-raising; later this material was used for the manufacture of laths and boxwood but this use has now given way to the supply of the sulphate cellulose industry. Charcoal is still made by slow combustion in specially prepared stacks.

In the development of these industries there has been a great deal of economic integration, but company mergers have only exceptionally proceeded as far as in North America where the Rothermere and Beaverbrook concerns possess their own mechanical pulp, cellulose and paper mills to feed their printing presses. The largest of the companies in Sweden is the *Svenska Cellulosa AB* which in 1962 produced 0·5 million tons of pulp for sale, 0·34 million tons of paper and 75,000 standards of wood from the $3\frac{1}{2}$ million acres (1·4 million ha.) of productive forest it holds. The greatest organisation in Finland is the *Enso-Gutzeit-Tornator* (87 per cent of whose shares are held by the State) which employs 25,000 persons; it has expanded tremendously from its foundation in 1872 and runs its own hydro-electric plant, sulphate and sulphite mills, mechanical pulp mills, papermills, chlorine laboratory and waterglass factory and the exports represent about one-tenth of the export trade of Finland. At the same time as individual firms have brought a chain of processes under one control there have been a number of horizontal forms of integration, principally by joint selling organisations which even

extend beyond political frontiers. Match manufacture has been brought into a cartel arrangement and in 1937 *Svenska Tandsticks AB* had a monopoly of match sales in Greece, Hungary, Lithuania, Romania, Yugoslavia, Bolivia, Ecuador, Peru, and Guatemala and in addition supplied matches to Germany, Belgium, France and Britain. In order to maintain the production, aspen was bought from Russia. Thus in both raw materials and manufactured goods the Fenno-Scandian area has worldwide connections and plays a considerable, indeed a vital part, in the supply of consumer goods and the basic material for other industries.



CHAPTER 17

FISHERIES AND THEIR PRODUCTS

The richest fisheries of the world are in the northern hemisphere and of these fishery grounds the banks of the North Atlantic around the Færoe Islands, Iceland, Bear Island and off Norway are particularly valuable. Stormy as these waters can be, they nevertheless support great fisheries. In winter the days are short and the work is arduous.

FIG. 146.—SEA ICE AND THE IMPORTANT FISHING AREAS.

The limits of the ice are very variable and the limits shown are therefore approximate particularly at the present time when the northern seas are getting warmer.

Europe has a greater length of coastline, compared with its area, than any other continent and in Europe the northern coasts have an exceptional degree of accidentation which provides innumerable sites for fishing harbours. Into the bays and fjords of these shores, with the exceptions of Greenland in the west and the Baltic and its

gulfs in the east, penetrate warm air, if not warm water, which has travelled north-eastwards across the Atlantic, and the coasts are kept ice-free in the relative winter warmth. From time immemorial fishing has been practised on these shores; formerly for local subsistence only, it has expanded into a great and highly-organised modern industry. A relic of its former significance is that the water-front villages in Scandinavia have certain inalienable rights of fishing.

There is a great variety of bottom conditions in Scandinavian waters. Rocks occur on the steeply plunging submarine slopes whereas the level floors, which may be 200 fathoms (366 m.) below the surface, may be mantled with mud or sand. In the shallow sandy areas which are particularly well developed round Denmark occur flat fish, prawns, cod and haddock and, in deep water, halibut. The many channels between the islands of Norway and Bohuslän concentrate the movement of the shoals.

Not all the fish caught in these waters are landed on Scandinavian shores and the proportion landed elsewhere increased with the adoption of mechanical propulsion which allowed longer fishing trips. Where conditions are most strenuous, as off Iceland, there are found the largest vessels while the smallest craft, open boats, are used in the Baltic and in the fjord fisheries of Norway. The modern craft, such as the post-war trawlers of Iceland, salt the cod on board, extract the oil and crush the offal and heads. The capital invested in these modern craft is great, for example, the *Ben Lui* built at Aberdeen in 1955 cost £170,000 and the catch on each trip must be large in order to pay the running costs.

The number of Scandinavian fishing vessels engaged in the fisheries is considerable as is seen from the Table.

Number and types of fishing vessels in the northern countries 1953

	Non-Powered	*Powered*	*Powered of which steam*
Finland . .	6,412	4,258	—
Sweden . .	9,476	10,182	—
Norway * . .	49,140	36,966	93
Denmark . .	6,201	7,766	—
Færoes . .	?	291	28
Iceland . .	3,140	719	—
Greenland . .	1,385	492	—

* 1952

(Based on F.A.O. *Year-Book of Fishery Statistics*, 1952–53, Rome, 1955, Vol. IV, Pt I. Tables 56 and 59)

Over 170,000 Scandinavians are engaged in the fisheries. In Iceland and the Færoe Islands the vessels have hired crews whereas in the other countries they are worked by the owners or part-owners. Many men work only occasionally at the fishing and regard it as a part-supply of food or as a source of cash income. In Norway, where this used to be the general practice, fishing has tended to become a wholetime occupation but in the Lofoten fishery there is still the problem of reducing over-employment giving severe hardship to the men concerned, to whom it may be the only opportunity of obtaining capital.

The traditional method of catching is by the handline, which is almost exclusively retained by the Færoese and is still common in Iceland and Norway. The cod are caught with herring, sprat or caplin bait; the supply of this is vital and has necessitated the provision of refrigerating plant. The Danes pioneered a seine-net for flat fishing from the west coast while the purse-seine for herring and brisling was evolved by Norwegians and Swedes.

As a result of the value to the nations concerned of these fisheries as a source of food, for trade and to train men for the merchant marine, the industry is well documented with voluminous reports and statistics.

The landings of fish, in thousands of tons, from North European waters in 1960 were as follows:

Fish landings, thousand tons, 1960

	North Sea	*Baltic and Skagerrak*	*Iceland and Færoes*
Denmark	340	208	—
Færoes	45	—	36
Finland	—	47	1
Iceland	—	—	542
Norway	196	19	87
Sweden	122	131	1
Germany	233	40	142
Scotland	153	—	41
England and Wales	107	0·07	201

(Based on *Bull. Stat. des Pêches Maritimes des Pays du Nord et de l'Ouest de l'Europe*, xlv, Copenhagen, 1962, pp. 2–3)

Another way to examine the importance of these fisheries is to review the relative value of the various grounds and to scrutinise the percentage of the catch which is taken by the northern countries of Finland, Sweden, Denmark, Norway and Iceland from each ground and, as an example, the year 1934 is given.

Relative importance northern fishing areas, 1960

Fishing ground	*Yield of each ground as a percentage of total north and west European catch (excluding Mediterranean countries)*	*Percentage of the yield from each ground taken by northern countries*
North Sea	20·5	42·5
Kattegat and Skagerrak	3·0	99·8
Belt Sea	0·4	63·0
Baltic	5·4	35·7
Norwegian Sea	18·4	62·3
Barents Sea	9·8	35·3
Svalbard	2·3	7·6
Færoese grounds	1·2	21·0
Icelandic grounds	13·0	65·1
Greenland and Newfoundland	1·1	58·3

(Based on *Bull. Stat. des Péches Maritimes des Pays du Nord et de l'Ouest de l'Europe*, xlv, Copenhagen, 1962, pp. 2–3)

While the catch of the northern countries is about two-fifths of the total quantity the value is under one-fifth for much of the catch is sold on the poorer markets: the Icelandic and Norwegian cod is largely used for oil and meal or for klip and stockfish which sell at lower prices than where the fish is consumed fresh. Competition in the sale of salt fish came from the fishermen on the Newfoundland banks but Iceland had an advantage in having a nine months' season and being nearer the consuming centres so that a higher proportion could be sold fresh or "green" to the merchants. The quantities caught in 1933 and 1960 by these countries were considerable when expressed per head of population:

Catch per capita

	lb. per head of population	
	1933	*1960*
Iceland	6,400	7,410
Færoes	2,446	7,392
Norway	897	981
Denmark	46	279
Sweden	35	75
Finland	22	29
United Kingdom	46	40
Netherlands	29	59
France	15	29
Germany	13	29

(Based on *Northern Countries*, 1937, p. 44, *U.N. Statistical Yearbook, 1951*, Table 35, and *ibid., 1961*, Table 35)

Since the war Norway has caught the greatest quantity of fish of any European nation, rivalled only by the United Kingdom.

Total weight of sea and inland fisheries '000 metric tons
(Excludes whale and seal products. Post-war live weights)

	1931	*1938*	*1960*
Denmark	88·0	97·1	581·2
Færoes	—	63·0	116·3
Finland	17·9	44·4	66·0
Greenland	—	4·7	27·4
Iceland	232·1	327·2	592·8
Norway	740·4	1,152·5	1,598·9
Sweden	—	129·2	197·4
United Kingdom	1,041·2	1,198·1	923·8

(Based on *U.N. Statistical Yearbook, 1951*, Table 35, and *ibid., 1961*, Table 35)

Cod fishing is the chief element of the Norwegian fisheries: the catch being taken from both the coastal and the Arcto-Norwegian waters, the fishing of the latter is a seasonal activity for in late winter and early spring shoals of cod come in from the Barents Sea to spawn. While cod are caught through most of the year between Finnmark and Lindesnes the great cod fishery lasts from January to April, using Lofoten and Vesterålen as base, and from April to June from the Arctic shores, there are great variations in the catch and the causes of the periodicity are unknown. Out of these seasons fishing is carried on off Bear Island, Spitsbergen, Iceland and Greenland and cod is brought back to be made into klipfisk.[1] Off Iceland cod are caught through most of the year but the great early spring fishery, off the south and south-west of the country, is the most important. In February the cod move in to spawn in immense shoals from waters west of Greenland; then the shoals, having spawned in the warmer Icelandic waters, return to the cooler waters. As early as the fifteenth century Norwegian and English fishermen were producing stockfish from cod caught in Icelandic waters but, as so often happened in European fisheries, the Dutch were also early on the scene and during the eighteenth century, until stopped by war in 1781–2 and again by the Napoleonic Wars, they were sending many vessels to Icelandic waters: for example, in 1768 160 vessels sailed to the cod fishery. The catch was either salted or dried.[2]

[1] *klipfisk*, split, salted, pressed and dried; *stockfisk* beheaded, gutted and dried.

[2] The Dutch termed this cod *Kabeljauw* or *baccalauw* which resembles the Portuguese *bacalhao*, dried cod: the similarity is close and may be a relic of the former shipment of Dutch dried cod to Iberia.

Besides the Icelandic vessels, British and German now fish these prolific waters heavily and the Icelandic Government succeeded in 1952 in extending their control over adjacent waters, copying the Norwegians, who had, a year earlier, successfully appealed to The Hague Court. By 1960 both Iceland and Norway lodged 12-mile claims for territorial water limits.

Danish and Swedish cod fishing is mainly in the North Sea and the Kattegat, although some takes place in the south of the Baltic and the catch is largely exported fresh to Great Britain and Germany.

The Færoe Bank is a plateau of about 1,200 sq. miles (3,108 sq. km.) with an average depth of about 60 fathoms (110 m.) and is part of the ridge which lies athwart the Gulf Stream Drift and swarms with the microscopic life on which fish feed. From about 1817, vessels from the Shetland Islands were fishing towards the Færoe Islands and during the next forty years it was a regular practice to sail in March to these codbanks. In the autumn the well-vessels sailed: these had a hold with holes to let sea water in and the live cod were placed in the well and when the catch was complete the cargo was carried to Hull; the cod could thus be at London fishmongers within twelve hours of killing. The Færoese learned cod fishing as an industry from these Shetland Islanders on the Færoese bank: indeed their first boats were purchased from their mentors. The Færoese fishing is still carried on by handline, although in the post-war years they have purchased large, modern trawlers, and the vessels make one or two trips in the spring and summer to Icelandic and Greenland waters. The Greenland voyage is not a twentieth-century innovation, for in 1842 a Shetland Islands vessel fished the Disko Bank in Davis Straits and found that cod, while prolific, was coarse and the flesh was impregnated with oil. About 1920 the sea began to get slightly warmer off Greenland and the cod shoals spread north; they are fished now by Greenlanders with handlines, for trawl and seine-nets are not easy to manipulate in these seas. The cod are older and larger than those caught off Iceland or Norway. The territorial waters of Greenland have been opened to Færoese fishermen while Færingerhavn near Godthaab has been made a Norwegian base. Pre-war Finnish vessels trawled for cod in the Arctic Ocean.

Salting of herring must have been practised for centuries before William Beukelsz of Biervliet discovered the technique of curing. This Dutchman originated in the fourteenth century the first, and for long the only practicable way of preserving herring, and this discovery was made about the time the shoals left the coasts of Sweden and Denmark and migrated to the British coasts.

Herring fishing is carried on seasonally, especially by the Icelanders and Norwegians. The latter have four herring fisheries, the

"large", which passes into the "spring" (January to April), the "small" (April onwards), and the "fat" (after the "small"). The herring caught along the coast is used mostly for the production of oil and meal and, although the export of fresh herring has greatly increased, little of the catch is iced or salted for food. The scale of the catch of the "large" fishery is considerable and requires adequate shore plant: in 1950 over 35,000 tons were caught in one day's fishing. The Danes and Swedes also exploit the North Sea herring shoals while the Finns join them in catching the Baltic herring,

A.C.O.] [*August, 1938*

FIG. 147.—HERRING BEING UNLOADED AT AKUREYRI, ICELAND.

In recent years the catch of herring has been negligible but in 1956 large shoals were again near the coast.

strömming. To the Finns and Swedes, the herring is the most important catch. The herring fishing of Iceland occurs in the summer along the north coast; the northern countries participate and in some cases the catch is dealt with by using "mother ships". From the Finnish port of Lovisa from 1930 to 1939 large vessels sailed to Iceland and the catch was cured on a mothership but most of these vessels were lost in the war.

A feature of herring fisheries is the periodicity of the scale of catches; the reasons for the irregular rhythm are not yet known. At the beginning of last century the dense shoals of herring suddenly deserted the Bohuslän coast and left the fishermen in distress but the

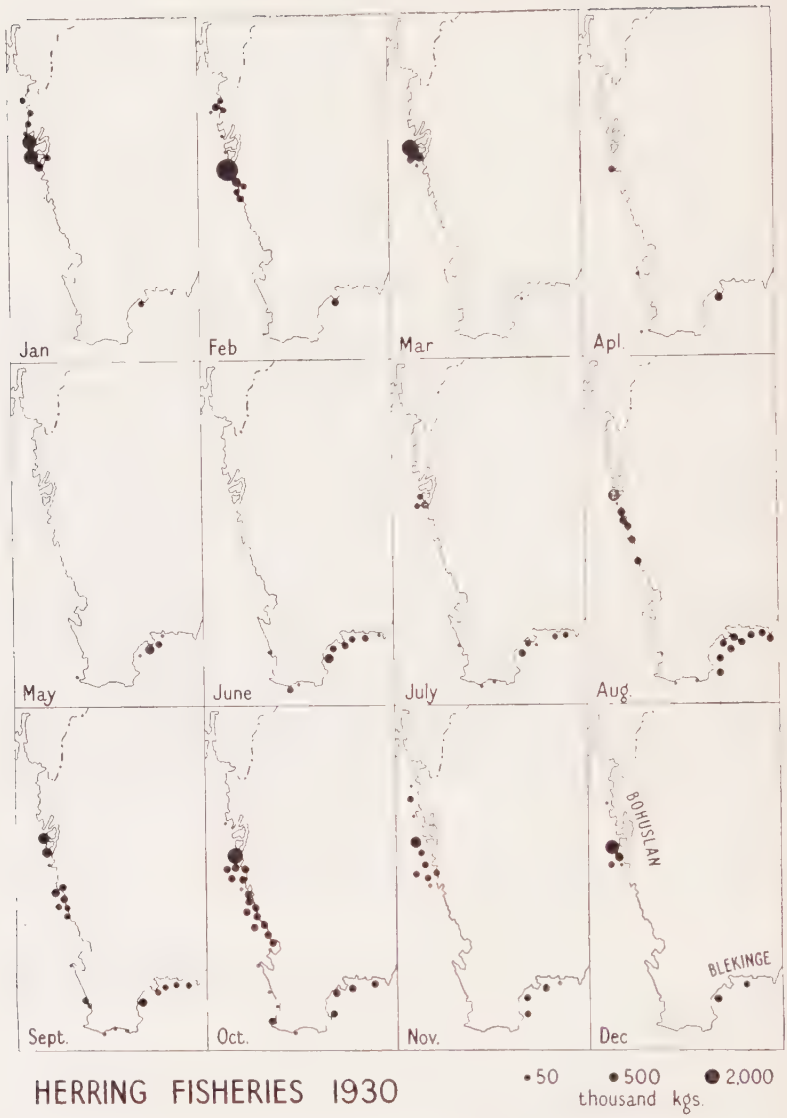


FIG. 148.—HERRING FISHERIES ON THE SWEDISH COAST, 1930.

The seasonal changes in the herring catch, resulting from the migrations of the shoals, are equivalent to those in other northern waters.

Based on "Herring Fisheries, 1930", *Bull. Stat. Pêches Marit.*, XIX.

government of the day encouraged the men to ply their craft off the coast of Norway. After 1877 the shoals again penetrated the waters round the rocky inlets of Bohuslän but they came as spent herring after spawning. The revival of the Swedish herring fishery was aided by the migration of Scottish curers to Bohuslän. Similar, but greater, cycles of good and poor herring catches have been experienced in the Norwegian winter herring fisheries. In recent years the Norwegian Research Vessel *G. O. Sars* located shoals in the open sea between Jan Mayen and Iceland and traced their spawning migration in the autumn towards the Norwegian coast.

From 1936 Norwegian fishermen started catching halibut by nets at considerable depths but the Færoese and the Norwegians on the banks off the west of Greenland continue to use handline for halibut. In Iceland the catch of *Norway haddock* became important during the inter-war period for the sake of its vitamin-rich liver, the rest of the fish being used for oil and meal.

Flatfish, especially plaice, are principally caught by the Danes using the Danish seine-net and the yield is one-third of the total fishery value. Denmark, in conjunction with Sweden, has important eel fisheries in the sheltered coastal waters within the Skaw: much of the catch is sent to Germany and the Netherlands. Dogfish, salmon, mackerel and brisling are also important items of the annual catch. Swedish and Norwegian fishermen frequent waters off the north of the Shetland Islands for mackerel which they cure on board. The Greenland shark is caught for the sake of its oil-rich liver, which is processed in Denmark.

Crustaceans and shellfish are important also; Norway produces crabs, lobsters and prawns and Denmark has specialised in oysters. An interesting development has been the cultivation of oysters, brought from the Netherlands, in Lim fjord: the collected mature oysters are cleaned and distributed from Ørodde, near Nykøbing (Mors). Prawns and shrimps are caught in Disko Bay on the west coast of Greenland and deep-sea prawns off southern Greenland: the catch is either frozen or canned for export.

Much of the fish catch of Scandinavia is exported fresh, iced, frozen, dried or cured. The remoteness of the northern fishery grounds has been a source of concern. It was in order to transport fish southwards that the heavy construction works, costing £2½ million, were incurred to connect Åndalsnes, by the Rauma Railway, with the south. Again it was the sight of fish expresses from Aberdeen which inspired a Norwegian to canvass for a railway from Bodø to the south, a dream which has now come true.

Much fish is preserved by deep-freezing of fillets and the markets for frozen cod, haddock and halibut have been extended from

southern Europe to the United States. A recent development by the Danes has been the provision of a floating freezing plant, a converted corvette, which carries frozen Greenland cod fillets to the United States market *via* Boston or New York.

In the dried-fish trade Norway has dominated the Argentine market while Iceland has captured that of the Dutch and British Guianas. With the increased production of cod by Iceland, from the employment of trawlers—it rose from 51,000 tons in 1925 to 70,500 in 1930 and 300,000 tons in 1960—new markets had to be found and the Newfoundland fish were partially displaced from the markets of Iberia and Italy.

In this century trawlers have progressively enlarged the area of the

A.C.O.] [*July, 1932*

FIG. 149.—NORWEGIAN FISH-VAN FOR SUPPLYING THE GERMAN MARKET [p. 259].

seas worked as various areas experienced depletion of their fish numbers; the Iceland grounds were first visited by British trawlers in 1891, those round the Færoe Islands a few years later, and in 1905 English trawlers commenced to make the 3,500 miles (5,600 km.) voyage to fish in the Barents Sea. In 1907 to England alone were brought about 115,000 tons of demersal fish from the grounds round Iceland and the Færoe Islands and the local fishing interests naturally began to fear the effect upon their nationals. If the three-mile limit be accepted and trawling be regarded as possible beyond that to a depth of 100 fathoms (nearly 200 m.) the Iceland region has only 36,600 sq. miles (95,000 sq. km.) available, compared with nearly ten times that round the British Isles, so it was feared over-fishing could occur rapidly and in 1958 the limit was made twelve miles.

The value of the sea fisheries has made real the problem of *Mare Liberum* and it was not by chance that the most vigorous exponent

and defender was the Dutchman, Hugo Grotius, for the Dutch with their short coast had to go beyond their immediate waters to build up their great fisheries—herring, cod and whaling. The opponents and supporters of the contrary belief of *Dominium Maris* included Britain and Denmark, which kingdoms adjoined productive fishing areas, and Welwood and Seldon were legal writers who supported the concept of *Mare clausum*. Denmark interfered more than once with the Dutch whale and cod fisheries for they claimed a closed sea as a broad fringe of four miles (6 km.) from Greenland, Iceland and Spitsbergen, and friction arose between these nations in the seventeenth and eighteenth centuries. In this twentieth century the Icelanders wished to extend the territorial waters control to seven miles but in 1901 Denmark agreed to a limit of only three miles. By this and other agreements, Denmark abandoned the traditional Norwegian and Swedish limit of one-fifteenth of a degree, i.e. four geographical miles outside an imaginary straight line joining outermost visible isles or rocks. The effect of this can be seen in the sea area between Sjælland and Jylland where the old limit enclosed a far greater area than the modern. Much more important is the area of Vestfjord where the fisheries are regarded as reserved for Norwegian nationals although the distance between the enclosing points of land (Moskenæs and Stot) is 45 miles (72 km.). The area so enclosed is about double that comprised within the ordinary limits. After many disputes Norway won her case in 1951 by appeal to The Hague Court. One practical argument advanced is that the fisheries are vital to other nations as well as Norway, and that if the ordinary boundary be adhered to the intermingling of territorial and non-territorial waters which results from the very irregular coast would cause endless difficulties in practice. While Norway has long put forward this claim it did not become a live issue until the introduction of large steam trawlers allowed fishing far from a base port.

BALTIC FISHERIES

Of the true sea-fishes only the small Baltic herring (*Clupea harengus*) is found in sufficient quantities to form the basis of a widespread fishery, but in the south the higher salinity allows the sea fish to flourish, such as the cod, turbot, dab, plaice and flounder. Cod are caught as far north as Örnsköldsvik and along the Swedish Baltic 8½ million lb. (4 million kg.) of cod were caught in 1959. The deeper parts off Central Sweden are poor in fish life owing to a deficiency of oxygen; farther north, in the deeper areas of the Åland Sea and of the Gulf of Bothnia, few fish exist, for while the oxygen content is adequate, the low temperature and reduced salinity make the

conditions unsuitable. This poverty in the deeper waters explains why only coastal fisheries have developed.

Evidence of Stone Age finds shows that the coastal fishing was of value to primitive man. During the Middle Ages the great herring wealth of the Baltic was instrumental in enriching the coffers of the Hanseatic cities until the herring shoals ceased to frequent these waters of the Baltic. After the decline of the great fishery there were only small catches by the local fishermen who normally lived in towns such as Gävle and Öregrund and migrated to outlying villages on islands during the summer season. Few of these sites are now occupied, for the motor-boat has revolutionised techniques. Probably one-third of the Swedish fishermen were part-time and most of these were engaged also in agriculture. One feature is the occurrence of small colonies of fishermen; the largest on the Swedish Baltic coast are in Skåne, with just under 100 whole-time fishermen, whereas in Bohuslän the fishing villages have over twice this number. In the islands of Gotland and Öland, though the homes are scattered among the agricultural holdings, the boats and the net-sheds are congregated owing to the paucity of landing places.

The Baltic herring is the most important commercial fish and fishing ceases only during bad weather. During the freeze-up some herring are drag-netted under the ice. Bornholm is famous for its herring catches and the fishermen include Swedish immigrants for the island is better situated than the coast of southern Sweden to tap the shoals.

After 1920 plaice fishing became important in the Baltic, particularly round Bornholm, and it became necessary to protect the spawning grounds from overfishing. Eels are caught in the Baltic as far north as the Åland Sea and have become only second in average value to the herring catch.

Salmon and sea trout are caught in the Gulf of Bothnia where the fish enter the great salmon rivers. While salmon is the most valuable species of fish in selling price per unit weight, the yield is very variable. The distribution of the catch has been revolutionised by the motor vehicles which allow fish landed at the various creeks to be distributed fresh in the interiors. At Stockholm there is a large fish auction hall which not only handles Baltic fish but some of the catch from the west coast and from the lakes.

The export of fish from the Swedish Baltic coast is difficult to trace in the statistics, but herrings and eels are exported in quantity to Germany. Salting of herring is only carried on along the coast of Sweden and the produce is carried or placed in barrels. At Ystad in Skåne is the largest fish canning factory on the Swedish Baltic Coast. Bornholm is famous for its smoked herring, which are a delicacy.

FRESHWATER FISHERIES

Of less value than the saltwater catches the freshwater fisheries are important for their yield of salmon. Denmark also has a considerable catch of eels. In addition there is the hatching of fish for rod and net fishing. Salmon are relatively important in Finland, not only because of the quantity but also because the sea fisheries are not so well developed as in the other Scandinavian countries. Most of the salmon catch has to be preserved by salting or by smoking. Many of the catching centres are by the seashore, for difficulty has arisen from the construction of power stations across the rivers. From the remote lakes of Swedish Lapland salmon is carried by seaplane to the southern markets. The salmon does not occur in Greenland rivers but is replaced by char.

INDUSTRIES BASED ON FISHERIES

The simple preservation of fish by drying built up the export trade of cod from Norway: the average export 1846–50 was 53,745 metric tons and this had increased by 1877 to more than double despite competition from the Newfoundland fisheries.[1] After the First World War there was an intensification in the use of by-products and plant was constructed to handle products such as roes, tongues and sounds. Salting and drying of cod is still the most important stage before selling, for only one-eighth is sold fresh or frozen.

Canning of fish, especially brisling, sild-herrings, kippered herring, soft roes and crustaceans, is an industry of great value to Norway, particularly in the Stavanger to Bergen sector of the coast, but it is not of such value to the other northern countries. Two important developments in canning technique have been the introduction of aluminium cans and the substitution of olive oil by a special fish oil: these two features have reduced the imports and the costs. Herring is preserved by freezing and by hard salting as well as by canning.

Norway and Iceland have developed herring oil factories: Norway has some 65 factories along the west coast, round Ålesund and in the Trøndelag region, as well as a factory ship, while Iceland has seventeen. The meal, which in Norway is made from four-fifths of the herring catch, is used for feeding to livestock, while the oil can be used for edible fat. Norway has a financial interest in some of the herring oil installations in Great Britain while several of the Iceland factories are owned and operated by the State.

Norway is the world's leading producer of cod-liver oil, with Iceland second. Formerly the livers were allowed to rot and the oil

[1] For an account of this fishing see H. A. Innis, *The Cod Fisheries*, New Haven, 1940.

was collected as it ran out, but now the liver is steamed and the oil "expressed" fresh. Poorer grades of oil are obtained from haddock and coalfish livers. From the heads and bones of cod is obtained meal for the feeding of livestock, particularly silver foxes. The salted roes are exported to France as bait for the sardine fisheries.

WHALING

Clark has shown,[1] on the evidence of ancient rock engraving, that Stone Age man hunted seals, killer and pilot whales in the Norwegian, Danish, Bohuslän and Gotland waters. We know that whaling and hunting of walrus and seals has been carried on for over a thousand years for in Ottar's (Ohthere's) report to King Alfred he mentions that the tribute paid by the Finns included *inter alia* ship's ropes made of whale (walrus) hide and of seals.[2] The *King's Mirror*, written about 1235 A.D.,[3] contains an account of whales and seals which shows what a great part these animals played in the hunting and fishing life of the north. For an account of the catching of the Færoese caa'in whale see p. 320.

In the seventeenth and eighteenth centuries summer whaling on a large scale was carried on by British and Dutch. This is not the place to analyse the history of whaling enterprise but Figure 150 illustrates two features of the former whaling activity, in the rise in importance of an area and the subsequent over-catching which forced the taking-in of a new area to make good the deficiency. The high prices received for products from whaling encouraged others to enter northern waters and the Dutch, English and Basques all went whaling in these waters

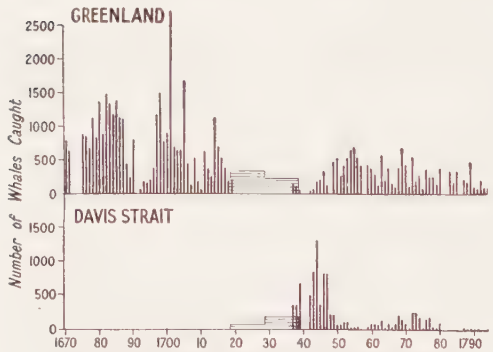


FIG. 150.—WHALING CATCH, 1670–1794.

Greenland was the former regional name for the Spitsbergen fishery and Davis Strait, later in being developed, for the western fishery. Note that for the 1720s and 1730s only average statistics for the decades are available.

Based on data in A. Beaujon, "The History of the Dutch Sea Fisheries", *Internat. Fish. Exhib. Lit.*, London, 1883, Appdx. B.

[1] Clark, J. G. D. *Prehistoric Europe*, p. 68 *et seq.*
[2] Quoted Nansen, F., *In Northern Mists*, i, pp. 175–6.
[3] *Ibid.*, ii, pp. 155–6 and p. 242.

despite Danish claims to sovereignty. Most of the whales then caught were of the Greenland right-whale species, and this supplied whalebone and oil from the blubber. As the stock of whales thinned out the whaling industry in northern waters greatly decreased until in 1868 the Norwegians introduced the explosive harpoon and made it possible to catch the large fin-whale. By 1885 the Norwegians had 33 whaling vessels operating from the Finmark coast but there were many complaints of damage to the cod fisheries and in 1904 whaling was banned from Norwegian shores and bases were established in Scotland, Ireland, the Færoes, Iceland and Spitsbergen; in spite of this, the catch had declined by 1913. Then the centre of gravity of the whaling fleet moved to the southern hemisphere whither the first factory ship had been sent in 1905, although the northern whaling had not passed its peak until 1910.

Norwegians have played a great part in the modern industry of whaling and many of the ships sailing under other flags have Norwegians on board as harpooners and other skilled workers: all told, about 7,000 Norwegians are engaged in whaling. Other countries now participate but still Norway produces one-third the world's output of whale oil. Since 1931 the catch has been restricted in order to conserve the whales. At first this control was fairly simple, as the shore concessions required were in the British Colonial territories of South Orkney, South Shetland and South Georgia but it was rendered less effective by the introduction in 1925 of the modern floating factory ship. It was the ruthless and reckless use of factory ships which forced prices down and compelled a voluntary limitation of the catch. Japan refused to enter the agreement, although Germany did, but in the three seasons 1936/7 to 1938/9 two Norwegian expeditions were hired by Germany to increase their supply of fat. During the war the Germans destroyed many of the whalers on the Antarctic fringe and this was a serious blow to the families who engaged in whaling from the Norwegian Vestfold ports of Sandefjord, Larvik and Tønsberg. In 1938 the Norwegians possessed eleven factory ships and 95 whalers which were owned and manned at these three ports. By 1960 the fleet consisted of eight factory ships and 86 catchers. The catch of whales and the whale oil produced is given below. In addition to the Norwegian fleet there are some Icelandic and Danish vessels, four and three catchers respectively, but the quantity of oil obtained is minute compared with the Norwegian output.

One branch of whaling activity still practised in northern waters is that by the Government whaler in Greenland; this is for human food but the blubber is exported for processing.

Whale oil is of high value and factories have existed in Norway

Norwegian whaling catch and oil production

Season	Norwegian		'000 tons production whale oil in world
	'000 whales	'000 tons whale oil	
1931/2	0·8	5	157
1932/3	12·6	223	441
1933/4	13·7	212	438
1934/5	16·9	210	456
1935/6	15·7	197	487
1936/7	15·9	202	545
1937/8	15·4	198	617
1938/9	11·9	145	510
1939/40	11·0	154	452
1940/1	4·4	41	215
1941/2	3·5	11	36
1942/3	3·5	12	36
1943/4	1·0	14	38
1944/5	1·8	25	52
1945/6	7·7	91	161
1946/7	12·9	169	372
1947/8	16·1	181	419
1948/9	16·6	190	441
1949/50	17·2	191	433
1950/1	18·0	196	503
1951/2	16·1	196	494
1952/3	11·6	141	437
1953/4	15·3	177	487
1954/5	14·8	149	470
1955/6	14·7	146	495
1956/7	15·2	172	497
1957/8	13·5	146	518
1958/9	14·3	141	495
1959/60	11·6	117	489
1960/1*	12·5*	126*	

(Based on *U.N. Statistical Yearbook, 1951*, Table 36, and succeeding issues)

* Antarctic only

since 1912 to harden the oil, along with seal and herring oil, for export. This hardened fat, of which over 100,000 tons a year are now made, is suitable for margarine, compound lard and soap.

SEALING

In the middens of the Stone Age, particularly in Gotland and Denmark, there have been found many fragments of seal bones and fragments of harpoons. To-day sealing is carried on by Norwegians around Nova Zembla and along the ice edge east of Greenland: the animals are shot or clubbed and from their carcases oil and skins are produced. Seals also occur along the coasts of Sweden: the common seal (*Phoca vitulina*) penetrates the Baltic as far north as Gotland,

while the ringed seal (*P. hispida*) is more frequently found in the Baltic than in more salt waters.

While sealing is not practised in the Baltic other than for sport, the ringed seal and the Kegel seal (*Halichoerus grypris*) are hunted in the Gulf of Bothnia when they are breeding on drift-ice from March to May. This hunting is of long standing, for the catching figures on a map by Olaus Magnus in 1539. About 3,400 seals a year are killed by Swedish hunters in the Gulf of Bothnia and about 1,400 off central Sweden, for their pelts and fat. The Swedish government pays a premium on each seal killed. Sealing is also practised by the Finns in the Gulfs of Bothnia and Finland: in 1944 in the former gulf about 2,100 were caught, in the latter 400 and in the south-west archipelago about 100. The hunters, in groups of four or five men, take a boat which they can draw up on a large ice-floe and use as a shelter. From this base they go on ice skis and by small boats to hunt the seals on the surrounding floes. The work is hazardous and the men are away from their homes for several weeks.

For centuries sealing provided the mainstay of life in Greenland—food, clothing, heat, light and implements—and on this basis of sealing the Greenlanders were independent of the outer world, but as the population increased so the older economy collapsed.

CHAPTER 18

MINERALS, METALS AND ALLIED INDUSTRIES

The mineral ore resources of Fenno-Scandia are of immense value including as they do iron ores of Sweden, Norway and Finland, the molybdenum in Norway, nickel in Norway and Finland, sulphide ores in Finland and Sweden, zinc in Norway and Sweden, copper in Norway and cryolite in Greenland. Although there are considerable outcrops of sedimentary rocks, containing such minerals as clay and limestone, particularly in Denmark, it is unfortunate that there are only limited deposits of coal and no mineral oil; these deficiencies are partly redressed, however, by the abundant water power resources which are still far from being fully developed. Major features revealed by a survey of the mineral resources are the small part played by Denmark, the Færoes, Iceland and Greenland and the immense importance of the metamorphism that has occurred in the Baltic Shield.

MINING AND QUARRYING

Iron-ores

The Danish iron-ore deposits are bog and lake ores which have a variable content of iron, averaging about 30 to 35 per cent, but are free from deleterious impurities. Unimportant as the deposits now are they were of significance in the military expansion of Denmark and production reached its peak in the two decades 1760–79 with an annual ore output of 7,500 tons.

Sweden, however, was the earliest large-scale producer of iron-ore and still is the leading country of Europe, though the centre of gravity of production has shifted within the country from the ancient workings of central Sweden to the great magnetite deposits of the north. The ores first exploited could be smelted with charcoal to produce iron for steel-making, and it was not until 1878, with the invention of the Thomas-Gilchrist "basic" process, that the phosphoric ores of Grängesberg, Kiruna and Gällivare were worth working. Whilst about one million tons of high-grade ore were retained annually for use within Sweden an export trade developed with Germany and Britain, countries which had the supplies of metallurgical coke to treat these phosphoric ores, the high iron content of which renders them exceptionally valuable.

The Kiruna iron-ore deposits, set in Pre-Cambrian rocks, are the largest in Europe, situated 190 miles (340 km.) from Luleå and 106 miles (170 km.) from Narvik; they form two large hills in which the ore-body is a lenticular lode dipping at 54°. Nearly nine-tenths of the ore has been obtained by open-cast work but now the whole of the output is mined. To obtain access to the ore the overlying

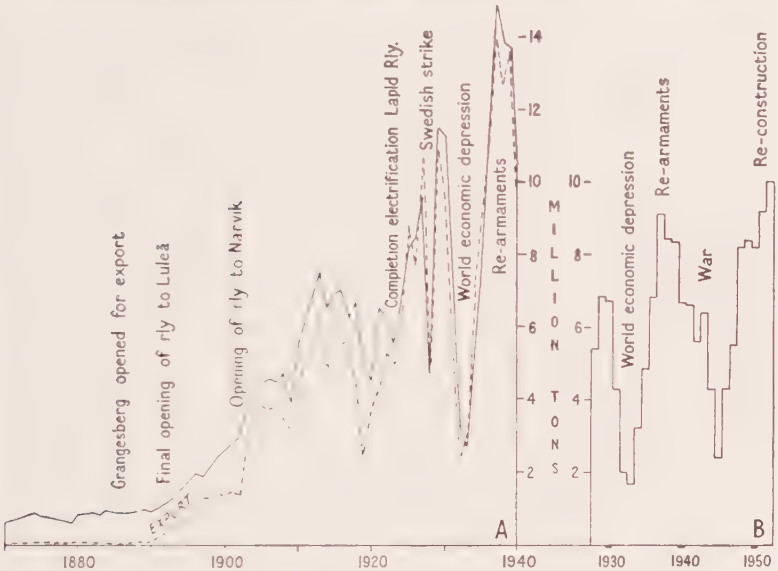


FIG. 151.—PRODUCTION AND EXPORT OF SWEDISH IRON-ORE.

The left-hand diagram (A) shows for the period 1870–1940 the gross output and export of iron-ores. In some years the export exceeded the output because of drawing on stock-piles. The cyclical nature of the trade is clear and it is controlled by causes outside Sweden. The right-hand diagram (B) shows the output 1928–52 by iron-content and overlaps with the previous graph. Some of the factors affecting production, such as the transport facilities, and some of the world trade controls are indicated above the graphs.

Based on various sources including *U.N. Statistical Yearbook* for 1948 and 1953.

porphyry had to be removed after blasting and then the ore is crushed, to about 4-in. (10-cm.) size. The crushed ore is taken to Luleå or Narvik; at the latter port are stockyards which hold two million tons. The importance of these ores, and an indication of the factors affecting the trade, is shown in the graphs of production and export (Fig. 151); much of this is controlled by one company.[1]

[1] The activities of Trafikatiebolaget Grängesberg-Oxelösund (T.G.O.) now include every aspect of iron mining, a considerable railway system 187 miles (300 km.) and a fleet of 33 ore-carrying vessels. It also controls an explosives

Large companies are required for the working of the Lapland ores in order to overcome the disadvantages such as the severity of the climate, high wages, and the difficulty of machinery maintenance in the hard winters. Working conditions must be regarded as arduous: for five weeks of the year Kiruna and Gällivare have uninterrupted darkness and all work is carried on by artificial light. For 250 days of the year the temperature is below freezing point and it has been known to fall to −62°F. (−52 C.). The rigours of the winter are to some slight extent offset by the prolonged daylight of the three summer months during which the weather is settled and there is an abundance of sunshine, although countless mosquitoes from the surrounding marshes detract from many of the benefits. Great care was devoted to the planning of these mining towns in an area formerly occupied only by nomadic Lapps: amenities for the workmen are provided and a sanatorium for the treatment of the now defeated northern scourge—tuberculosis.

The bog and lake ores, once significant in Småland, consist of dark brown particles forming a layer in a swamp or lake; they are obtained by dredging. Deposits may be up to 12 ft. ($3\frac{1}{2}$ m.) thick and the iron content is about 63 per cent.

Norway also exports iron-ores. In Dunderland there are large deposits of hæmatite-magnetite which, though valuable because of their low sulphur content, require concentration to raise the iron percentage to 65 or 70 per cent; the Sydvaranger deposits of magnetic taconite ore also have to be concentrated. After beneficiation the material is exported as "slick" or as briquettes. In Finland a titaniferous iron-ore, with magnetite and ilmenite which can be separated electromagnetically, occurs at Otanmäki and work started in 1952 on its exploitation, for this is by far the largest deposit of iron as such in the country, and hitherto the iron industry has principally depended upon pyrites which are mainly worked for their copper content. There is another ilmenite-magnetite ore at Sokndal in Norway; this is separated and concentrated as in Finland; but from the Norwegian mine ilmenite is the chief product from the operations, for it provides titanium oxide, at present used as a pigment but a possible source of titanium metal.

Reserves of iron-ore have been variously estimated and the quantities available offer a wide margin for all foreseeable working.

factory, certain power stations and also a general trading company. In 1903 T.G.O. by part purchase of Loussavaara-Kiirunavaara A.B. (L.K.A.B.) obtained control of the Lapland mines, except that of Koskullskulle. In 1917 T.G.O. entered the non-phosphoric ore market by purchasing mines in Austria and North Africa. In 1957 T.G.O. and L.K.A.B. separated and L.K.A.B., now state-owned using insurance funds, possess all Lapland mines except Tuolluvaara.

World Resources of Iron Ore

[In million metric tons for main orefields only]

	Proved	
EUROPE:		20,766
of which France	6,700	
Great Britain	2,300	
Sweden	1,870	
U.S.S.R.	4,400	
Spain	1,166	
Germany	1,500	
Norway	2,500	
AMERICA:		92,282
of which U.S.A.	74,182	
Brazil	13,000	
Newfoundland	3,000	
ASIA		13,600
AFRICA		7,045
AUSTRALIA		1,100
		Total 134,793

(Based on Percival, 1951: possible reserves not tabulated)

Details of the nature of the principal iron-ores in Scandinavia are given in the table on page 432.

Production of iron-ore is greatly affected by world trading conditions and is depressed during economic stress but rises under the threat of war.

Scandinavian Iron-ore Production by Iron Content, million tons

	1931	*1933*	*1938*	*1950*	*1960*
Sweden	4·3	1·7	8·4	8·3	13·2
Norway	0·4	0·3	1·0	0·2	1·1
Cf. Spain	1·5	0·9	1·2	1·0	2·8

(Based on *U.N. Statistical Yearbook, 1951*, Table 43; *ibid., 1961*, Table 43 and *Statistisk Årbog, 1952*, Table 286)

Iron-ore deposits of Scandinavia

Country	*Locality*	*Type*	*Iron-content percentage*	*Other content*	*Annual Production, million tons*	*Reserves, million tons*
Iceland .	North and west	Bog-ore	51			
Finland .	Otanmäki	Magnetite and ilmenite	37	7% titanium, 0·25% vanadium	—	50
Norway .	Dunderlandsdalen	Magnetite	36 to 39	0·32% phosphorus		300
	Sydvaranger	Magnetite-taconic hæmatite	32	Slight phosphorus and sulphur	1	
	Fosdalen	—	41	—	0·2	—
	Rödsand	Magnetite with ilmenite	35	5–6% titanium oxide, trace of vanadium	0·05	—
	Söftestad	Magnetite-hæmatite	58	1–2% phosphorus	0·03	—
	Sokndal	Ilmenite-magnetite	20	17% titanium	0·02	30
Sweden .	Near Kiruna and Central Sweden	Dry-ores (Torrsten)	50	Little phosphorus	—	—
	Kiruna	Magnetite	68	2–4% phosphorus, 0·05% sulphur	9	1,075
	Gällivare	Magnetite	63	0·3% titanium oxide, 0·7% manganese.	1·5	280
	Bergslagen		45 to 60	Traces phosphorus and sulphur.	—	50
	Grängesberg	—	60	1% phosphorus	—	150
Denmark	Langstrup, Østrupbæk and Løvsdal	Bog and Lake ores	F_2O_3 content 43	0·8% P_2O_5	0·003	—

SWEDISH IRON-ORE TRADE

Compared with the world total, Swedish reserves of iron ore are comparatively small, amounting to only three per cent. But this apparently small share is magnified if the high iron content is considered, for Swedish ore contains 55–67 per cent of iron, as against the 20–40 per cent of most other European ore-fields. European ores as a whole, without reference to iron content, represent 39 per cent of the world iron ore reserves, and this is a high proportion when the comparatively small area of the continent is considered. It must be remembered however that the newer countries may have reserves as yet unsurveyed. In respect of high grade ore Sweden possesses 92 per cent of European reserves. In 1912 Sweden produced 4·3 per cent of the world output (measured by metal content), in 1931 6 per cent and in 1960 5 per cent.

For the export of ore Sweden has a number of advantages in the size of the ore-bodies, their quality and transport facilities which are now relatively favourable; these combine to maintain her predominant position in the high-phosphorus ore market. Germany is by far the largest importer of Swedish ore. Prior to 1914 nearly 60 per cent of German iron-ore consumption was from within her own territory. The loss of Alsace-Lorraine after 1918 deprived Germany of two-thirds of her iron ore deposits and she needed to import four-fifths of her requirements. As a result the imports from Sweden rose from 33 per cent of German ore-imports (1909–13 average) to a 47 per cent average for the years 1921–34: in the post-war period this has been reduced again to one-third with the contraction in the German iron and steel industry but it is likely to increase again. Other countries were, however, also able to supply Germany and this became important during the Swedish strike of 1928. Until 1907 Spain contributed largely to German imports but the increasing Swedish production, combined with lower costs and higher iron content, gave Sweden the lead she has since maintained over Spanish sources, and Germany has become increasingly dependent on Swedish supplies. This growth was also largely influenced in the inter-war period by the Swedish-German clearing and payment agreements. However, the modern increase of Swedish exports has been greater than the rise of German imports. This is mainly due to the expanding market for Swedish iron ore in Britain where re-armament in the late 1930s coincided with the curtailment of regular supplies from Spain. As a result of the Spanish Civil War, though British imports from North Africa were more than doubled, the Swedish supply rose from 0·77 million tons in 1935 to 1·73 million tons in 1937. Though Britain has long taken ore from Sweden it has

not, until recently, been of major significance but by 1960 Britain took 17% of the Swedish export.

Other countries which took appreciable quantities from Sweden in the inter-war years were Czechoslovakia, U.S.A., Belgium and Holland. The export to the U.S.A. is limited by the long haulage and the fact that the iron and steel works of that country are not generally suitably located for the use of Swedish ores. In 1960 there was an export of 12·4 million tons from Narvik of which 2·5 million tons went to the United Kingdom: most of the remainder went to Western Europe, especially to Belgium, Holland and West Germany. The apparently high imports of Belgium and Holland are larger than the real consumption as imports destined for the Westphalian steel works pass through these countries.

Sweden is aware of the value of her iron ore for European consumers. Before 1957 the powerful producer T.G.O. was alive to the possible domination of European supplies through a co-operative arrangement with France. It may be said that the State and the people are averse to commercial schemes that may prejudice Sweden's relations with other powers. The calcium content of Lorraine Minette ores makes a valuable supplement to Swedish ores and this may have its effect on a possible combine. The Swedish North African deal by which the T.G.O. obtained control was suggestive of a link between the Lapland and French minette ore owners as the the latter held a large block of shares in the Ouenza (Algeria) Company also. In 1928 the T.G.O. purchased rights in the rich iron-ore deposits at Algarrobo in Chile. Such a purchase shows that the T.G.O. is bent on extending its influence over the world trade in iron ore. By 1959 the T.G.O. was working Liberian iron-ores.

The movement of Swedish ore in such quantities involved the creation of rail and port facilities. At Narvik there is a long quay and vessels are loaded by chutes, re-equipped with new gear in 1950; some difficulty is experienced in winter through the freezing and consolidation of the ore in the stock piles and in the hopper trucks. The rated capacity of this port is 6,000 tons an hour and practically all the ore is drawn from the Kiruna district, whereas most of the Luleå shipment is from Gällivare. The rail rates in 1935, in kroner per ton, were:

District	*To Narvik*	*To Luleå*
Kiruna: Kiirunavaara and Luossavaara . .	3·10	3·85
Gällivare: Malmberget and Koskullskulle . .	3·78	3·10

The protected harbour of Luleå can handle 1,650 tons of ore an hour, but owing to the winter closure by ice it ships a quarter of the Narvik tonnage, although it has a shorter sea route to the chief importing centres. Oxelösund, open throughout the year, has handled the export traffic of the Grängesberg mines since 1865 when rail connection was provided by the mining company: the loading appliances cannot handle the ore so rapidly as at Luleå or Narvik but are better than those at the ore-quay at Gävle.

Pyrites

Between the White Sea and the Atlantic Ocean there occur many deposits of pyrites but the mineral content varies, for there may be 25–50 per cent sulphur and up to 2·5 per cent copper, while some pyrites contains zinc which is extracted in the process of concentration. With the modern demands for sulphur, a key substance in many processes, part of the pyrites is produced as a source of this material. Norway exports most of her output but Sweden and Finland need to supplement their production by imports to meet the vast requirements of the cellulose and sulphuric acid industries. The table below summarises information on deposits of iron pyrites in the northern countries.

Principal Pyrites Deposits

Country	*Locality*	*Content*	*Notes*
Finland	Outokumpu .	28% iron, 3·5% copper, 25% sulphur, 1% zinc, 0·2% cobalt, 0·1% nickel. Some gold, silver, tin.	Annual output 0·6 million tons.
Norway:			
non-cupriferous	Stordø .		Concentrates to 39·5% copper.
	Bjørkåsen .		Annual output 0·1 million tons.
cupriferous	Sulitjelma .	5–10% copper-iron and zinc sulphides. 90% iron sulphide.	Annual output 0·1 million tons.
	Løkken .	42% sulphur, 2% copper, 2% zinc: traces of gold, silver, cobalt, cadmium.	Annual output 0·5 million tons.
	Reitan (near Røros) .	46% sulphur, 2% copper.	
Sweden	Boliden .	24% arsenic, 1·25% copper. Some gold, selenium, platinum, palladium, iridium	

The Norwegian deposits of pyrites at Røros and Sulitjelma vary from massive bodies to flat beds which may be of considerable size; for example at Røros one of these beds is 26¼ ft. (8 m.) thick and has an area of some 6,100 ft. by 330 ft. (1,900 m. by 100 m).[1] Pyrites, which in Norway has but a slight arsenic content, is the most important Norwegian mineral, but it needs to be concentrated before smelting: by newer methods such as the Orkla process, required for finely disseminated material, the sulphur and copper are conserved but the iron and zinc are wasted. There are many deposits, estimated at a total reserve of 50 million tons, and the annual output is about three-quarters of a million tons.

Since about 1930 copper pyrites, which was discovered in 1910, has been mined at Outokumpu in south eastern Finland. This valuable ore body has been responsible for some industrial development, for in addition to copper smelting and sulphur production, the largest iron-works in Finland has been created to use the iron concentrates which are derived as a by-product. The production of copper exceeds Finnish requirements and so some has been exported. About 1927 electrical prospecting located the valuable Boliden deposits of sulphide ores in Sweden which, containing several elements, have been extensively worked (see p. 149), but with the embarrassment of vast quantities of arsenic which are produced during the treatment of the ore.

The quantities of pyrites mined in representative years, and the sulphur content obtained, are summarised in the following table.

Tonnage figures in thousand metric tons

	Finland		*Norway*		*Sweden*	
	Pyrites	*Sulphur*	*Pyrites*	*Sulphur*	*Pyrites*	*Sulphur*
1931 .	156	40	360	160	58	23
1938 .	352	87	1,028	458	186	84
1950 .	647	149	749	318	407	202
1960 .	1,280	165	833	361	412	206

(Based on *U.N. Statistical Yearbook, 1951*, Table 60, A and B; and *ibid., 1961*, Table 61, A and B)

The average sulphur content of the pyrites during these representative years was in Finland 23·1 per cent, in Norway 44·4 and in Sweden 47·3: it is thus seen that Finland is working with poorer ores

[1] The cupriferous pyrites deposits near Røros were worked for copper from 1644 to 1920 and mining recommenced just before the Second World War.

and this is only made possible by the value of the iron content to Finland's economy.

Copper ores

The copper deposit at Falun, in Sweden, was once the most important in Europe and the long-continued working of this ore-mass was responsible for the early success of the oldest, still-surviving company in the world (see p. 132). The copper ores were found as an inverted cone, set in gneiss, extending down for some 1,200 ft. (366 m.) and owed their origin to thermal metamorphism. This ore-mass has yielded about half a million tons of copper during the long history of its working.

The enlarged mines and smelting works at Boliden can meet about one-third of Swedish requirements. This rich sulphide deposit has about 2·5 per cent copper and other elements of which the most useless, at present, is arsenic. Mention is made above of the copper pyrites of Outokumpu in Finland and these deposits which consist of sulphide ores containing copper, zinc and lead, have been a major source of copper to Finland. Amongst the European countries only Yugoslavia and possibly the Eastern Zone of Germany have had a greater production of copper ore since the war. The lodes, which occur in a zone of contact metamorphism, have been extensively worked to provide over half a million tons of ore, which is concentrated before being despatched to the smelter at Harjavalta. A low grade copper ore is also worked at the Paroinen mine and the concentrate has to be carried by road for 10 miles (16 km.) for railing to Harjavalta smelting plant. Another Finnish mine, the oldest producing unit, is at Orijärvi, and although the copper content is only one per cent the ore body also contains lead, zinc and precious metals which justify working. A new working at Aijala has a higher copper content (2·2 per cent) and the concentrate also goes to the Harjavalta smelter. The crude copper from this smelter is electrically refined at Pori and the copper bar produced has only 0·01 per cent impurity: it is in this last stage that gold and silver are obtained.

At Sulitjelma and at Løkken in Norway pyrites is mined for its copper content, as well as being a source of sulphur, and there is a considerable output which is conveyed by rail towards the coast. The Sulitjelma copper is now smelted in electric furnaces. At Thamshavn the Løkken pyrites is treated for sulphur and the production of copper matte. At Røros copper was mined from 1644 and, after an interruption, production has recently been restarted with a copper output of 700 tons a year; the copper is smelted in oil-fired furnaces. There are many other deposits of pyrites which

are worked partly for their copper content. Copper is also worked in Telemark from narrow veins, the most important centre being at Åmdal.

Copper Ore Production by Copper Content, thousand metric tons

	Finland	*Norway*	*Sweden*
1931 .	6·4	8·7	1·6
1938 .	14·1	21·6	9·3
1949 .	20·5	14·9	16·3
1960 .	30·5	15·4	17·5

(Based on *U.N. Statistical Yearbook, 1951*, Table 44, *ibid., 1961*, Table 44 and *Statistisk Årbog, 1952*, Table 286)

Zinc and lead ores

Of the several zinc deposits in Sweden, only that at Åmmeberg is worked and the ore goes to Norway or Belgium for smelting. The main producing centre in Norway in this century has been in the north at Mofjellet in Rana where the 5·5 per cent of zinc is raised to 52 per cent after concentration, the 0·7 per cent lead to 65, the 0·4 per cent copper to 25 and the 8 per cent sulphur to 68. Zinc is electrically refined in Norway using imported ores as well as the Mofjellet concentrate, and about 48,000 tons a year are produced at the Eitrheim (Hardangerfjord) smelter, the largest in Europe.[1] A small quantity of zinc-ore is produced in Finland at present but at Metsämonttu, in the south-west, a new zinc-ore body has been proved and will be exploited soon, while another possibility at Lampinsaari is being tested.

Lead-ore output in Sweden was greatly increased by the opening of the Laisvall mine by the Boliden company; since 1942 bar-lead has been smelted in Sweden and by 1960 over 44,000 metric tons a year were being produced. The Norwegian production, always small, has ceased except from Mofjellet, while the lead mines and concentration plant at Peuravuono fjord near Petsamo and at Säkkijärvi passed from Finnish to Soviet control after the Second World War. The only producing mine in Finland is at Orijärvi and even so most of the lead comes from the old waste heaps.

[1] Cadmium and sulphuric acid are produced as by-products; to use up the latter, superphosphates are produced at Eitrheim.

Lead and Zinc Ore Production
in thousand tons of lead and zinc content

	Lead			*Zinc*		
	Finland	*Norway*	*Sweden*	*Finland*	*Norway*	*Sweden*
1932 .	0·4	0·9	7·3	1·4	8·9	24·5
1938 .	0·2	0·2	8·6	0·6	7·7	34·6
1949 .	0·2	0·3	29·8	7·6	6·6	35·2
1960 .	2·3	2·5	54·8	50·9	10·3	73·0

(Based on *U.N. Statistical Yearbook, 1951*, Tables 45 and 46, and *ibid., 1961*, Tables 45 and 46)

Nickel, Manganese, Molybdenum, Tungsten and Niobium ores

These minerals may be conveniently grouped together because the metals find their main use in ferro-alloys. Just before the outbreak of war in 1939 the nickel ores in the Petsamo district were opened up. The ore body, estimated to contain three to four million tons, has a two per cent nickel content and the workings soon became the most considerable in Europe. Both mine and smelting plant passed to Soviet control after World War II. Within the present territory of Finland, the Makola mine produces 20,000 tons of nickel ore a year, although all the concentrate has to be taken 10 miles (16 km.) by road before it can be forwarded by rail to Harjavalta refinery. Nickel ores in Sweden are of poor quality and working is only justified under war conditions. For a period the Rönnskär smelter treated Petsamo nickel ore. Nickel is also found in pyrites in Norway, and for a time Norway was a leading producer of nickel, but working has ceased owing to the competition from the rich Sudbury (Canada) and New Caledonian deposits; the last two Norwegian mines to operate were closed in 1946. The principal refinery is at Kristiansand South which was established in 1910 to handle Norwegian ore and now works mainly on Canadian nickel matte but also takes any available Norwegian nickel matte. By-products of the nickel refining are precious metals and sulphur dioxide which is used in the cellulose industry.

The only Scandinavian countries producing manganese ore are Sweden and Finland. The Swedish ore has a manganese content varying from 15–35 per cent. The Finnish output is obtained by the dredging of lake iron-ores, which are sent for treatment to Turku. At Kristiansand South imported manganese ores are refined.

Norwegian production of molybdenum, which comes principally from the Knaben mine, is the largest in Europe (although the ore-body

only contains 0·25 per cent molybdenum sulphide) and practically all the ore produced is exported. Finland produced this ore during the period 1940–7 in considerable quantities from the Mätäsvaara mine, but it proved unprofitable as the ore only contained 0·2 per cent of molybdenum sulphide (molybdenite). Since 1943 Sweden has produced a few tons each year.

Tungsten ore is worked in Norway and Sweden and also as a by-product at the Paroinen copper mine in the form of scheelite. The Swedish production of scheelite is only sufficient to meet about a quarter of the country's requirements. This scheelite, which contains 0·5 per cent of WO_3, concentrated to 65 per cent, is mined at Yzsjö in Ljusnarsbergs parish.

At Ulefoss, near Skien in Norway, is found the ore columbite which contains the metal niobium. The ore only has a slight percentage of niobium oxide but in the concentration process apatite is also produced. Niobium has proved of value in the construction of jet engines.

Production of Steel-hardening Minerals, thousand tons

	Finland	*Norway*	*Sweden*
Nickel content of ores:			
1931	—	0·5	—
1938	—	1·2	—
1949	—*	—	—
1960	2·4	—	—
Manganese content of ores:			
1931	—	—	2·7
1938	—	—	0·5
1949	—	—	2·4
1960	—	—	—
Molybdenum content of ores:			
1931	—	0·1	—
1938	—	0·5	—
1949	—*	0·07	0·005
1960	—	0·2	—
Tungsten, WO_3 content of ore:			
1931	—	—	—
1938	—	0·01	0·1
1949	—*	—	0·3
1960	0·02	—	0·2

(Based on *U.N. Statistical Yearbook, 1951*, Tables 42, 50, 51 and 52, and *ibid., 1961*, Tables 50A, 51, and 52)

* Finland produced nickel ores 1941–7, peak production 9,000 tons in 1943; molybdenum ores 1940–7, peak production of 408 tons in 1941; and, since 1943, a small quantity of scheelite concentrate at the Paroinen mine.

Precious metals

At the Parionen copper mine in Finland silver ore is obtained in the concentration plant, which yields about 1,320 lb. (600 kg.) of silver a year, while from the waste of the Orijärvi mine come silver and gold. The Haveri ore body, which used to be mined for iron ore, is now being worked for its gold and silver content, with a small quantity of copper as a by-product, whereas from the Pori copper refinery gold and silver are obtained as by-products. In addition, in Lapland placer gold is obtained from the Lemmenjoki and other rivers. Boliden (see above and p. 149) has been the greatest source of gold in Sweden, while Sala has been important for silver. The most important silver workings in Norway were at Kongsberg which had been worked for over three and a quarter centuries, but when they closed down in 1957 gold had never been produced in quantity.

Gold and Silver produced

	Finland		*Norway**	*Sweden*	
	lb.	*kg.*		*lb.*	*kg.*
Gold					
1931	79	36	—	4,217	1,917
1939	317	144	—	16,020	7,282
1948	966	439	—	5,493	2,497
1960	1,485	675	—	6,230	2,832
Silver-ore, metal content metric tons					
1931	0·6		9·8	11·3	
1939	0·6		7·8	35·0	
1948	5·3		5·3	35·5	
1960	12·1		—	81·9	

(Based on *U.N. Statistical Yearbook, 1951*, Tables 55 and 56, and *ibid., 1961*, Tables 56 and 57)

* Gold is obtained as a by-product in nickel-refining at Kristiansand.

Non-metallic minerals and quarry products

Igneous rocks are quarried extensively in Scandinavia where there is access to sea transport. In Finland, Sweden, Norway and the Danish island of Bornholm granite is quarried for paving setts and hewn kerbs because of the rectangular jointing, while it is also produced for export, as well as home trade, for use as monumental stone, for it occurs in a range of colours not obtainable in Britain. Many of the so-called granites of commerce are actually other types of igneous rock, for example diorites and gabbros. From Norway *laurvikite* is exported and this handsome soda-syenite rock is in demand for shop fronts. Quartzite is quarried in Finland for grindstones used in pulp mills and the material is of such quality that

there is an export of these stones. Quartz is also quarried in quantity in Norway for electro-chemical purposes while from granite pegmatites felspar is extracted for grinding down to manufacture ceramics.

Asbestos is mined and quarried in Finland and the annual post-war production of about 10,000 metric tons makes it fourth in Europe. The fibrous material is manufactured near Helsinki into boards, packing and insulating material. Until 1956 Norway produced magnesite but the average yearly output was now below a thousand metric tons. Dolomite is produced in quantity as a raw material for electro-metallurgical purposes in Norway. This rock is quarried for melting down to be blown into the insulating material known as rock wool.

Cryolite finds its principal use as a catalyst in aluminium production during the electrical treatment of bauxite. It is found in Greenland and the output has depended mainly on the growth of the world's aluminium industries. Cryolite is quarried at Ivigtût and this is the only commercial working of the mineral, which can, however, be produced synthetically. Production of the mineral is controlled by a Danish company and about half the material is sent to København and the rest to Philadelphia in the U.S.A. for treatment and sale. Some of the cryolite is used in the enamelling of ironware.

Sedimentary rocks are also exploited in the Scandinavian countries. Cement is manufactured from limestone and clay or mud and the regions of Skåne, Gotland, Öland and Denmark, where these occur close together, are the chief centres of cement production. Limestone is quarried in Norway for the production of carbide. In Finland the output of limestone and dolomite is increasing both for industrial and agricultural use. The fireclay used for earthenware and firebricks in Skåne is a bedded material associated with the coal seams while the kaolin of Bornholm, used for pottery, is a decomposed granite. Kaolin is also obtained in Finland and used for chinaware in association with ground felspar and quartz which is quarried from pegmatites in the south-west: the main porcelain factory in Finland is near Helsinki. A by-product from these quarries is a supply of mica. Glass-sands occur and are worked but soda and potash have to be imported for the glassware manufacture which has become so important in Sweden.

INDUSTRIES BASED ON MINING AND QUARRYING

Iron, steel and non-ferrous metals

Iron production, based upon bog iron-ores and charcoal fuel, has been important in Scandinavia for a very long time. A furnace claimed to be on the site with the longest record of working in the world, exists at Vikmanshyttan in Dalarna: in archives at Uppsala

there is a document bequeathing a quarter-share in this furnace to Olof Törildsson, dated 25th March, 1360.[1] Pig-iron was produced from charcoal smelting in Norway in the sixteenth century, and it remained important until by 1800 the timber available for charcoal was exhausted. Those countries, such as Iceland, which had poorer supplies of ore or fuel, ceased production while the better endowed areas expanded their output until the discovery of coke-smelting meant that they could no longer dominate the world trade in pig-iron. Relatively they have fallen back, but Sweden still remains supreme for charcoal pig-iron and steel although it cannot meet the home demands for lower grade materials.

Before the First World War the annual charcoal consumption in the Swedish iron and steel industry was 5¼ million cu. yd. (4 million cu. m.) but since the advent of the electric furnace this consumption has been more than decimated: this is fortunate, for the pulp industry has taken much of the timber which would have been needed for charcoal. In the electric pig-iron furnace some of the charcoal is replaced by electrical energy and the charcoal consumption is only 45–50 per cent of that in a blast furnace. In the acid open-hearth furnaces which produce high-grade steels, producer-gas made from wood or peat is used to avoid adding the sulphur impurity found in coal and coke. During the last war the Swedish government financed a new company for producing pig-iron at Luleå which, with two electric furnaces, was to have a capacity of 60,000 tons of pig a year from 0·2 million tons of ore.

Electric steel furnaces are replacing the older basic open-hearth plant; the largest Swedish steelworks for merchant steel, Domnarvet, uses 25-ton electric arc furnaces, and electricity is also used for annealing steel though it is not used to heat steel for rolling or forging. The consumption of electricity in the iron and steel industry has expanded enormously: 1929 may be taken as a representative year in Sweden when in million kW-hours the consumption for pig-iron was 227, for steel 84 and for ferro-alloys 292. It is understandable why in Scandinavia the iron and steel industry has sunk so much capital in providing hydro-electric generating plant.

Electro-metallurgy, only possible if electricity is abundant and cheap, opened new opportunities and the electrical techniques have been adopted in Norway[2] and Sweden. The first successful

[1] *Amer.-Scand. Rev.*, xix, p. 370.

[2] Norwegian inventors have greatly advanced electrical techniques for processing: the Birkeland and Eyde electric arc furnace (for the production of nitrogen derivatives), the Søderberg electrode continuous operating system (for carbide, aluminium and copper), the Tysland-Hole furnace (for iron-ore smelting), the Hybinette process (for refining nickel), the Pedersen process (for producing alumina from bauxite with high-grade pig-iron as a by-product).

industrial use of hydro-electricity was the establishment of a calcium carbide industry by which lime and carbon are fused together at about 3,600°F. (2,000°C.) as a source of acetylene, calcium cyanamide, fertiliser and organic synthetics such as rubber. The carbide producers had a capacity beyond the demand and several turned to the manufacture of ferro-alloys. The production of these alloys, such as manganese, vanadium, silicon and chrome-steels, has led to the import of raw materials such as manganese ore as well as coal. Norway is a leading producer of ferro-silicon and the world's largest exporter. In 1953 a government-sponsored iron and steel works was established at Mo i Rana, with an initial capacity of a fifth of a million tons a year. These works, near the Dunderlandsdal ore field, are equipped with electric furnaces, acid Bessemer converters and rolling mills.

Electrical smelting and refining have also been applied to the treatment of ores of nickel, copper, aluminium and zinc, and this has revolutionised the industrial activity of Norway. This country is the fifth largest producer in the world of aluminium with about 165,000 tons in 1960, a figure which has more than doubled in under a decade; Sweden produced about a tenth of this quantity. On the other hand, whereas Norway produced about 20,000 tons of virgin copper in 1960, the Swedish output was 39,000 tons and the Finnish 31,000 tons. With modern plant the price of aluminium has greatly decreased: in 1860 the price per kilogram (2·2 lb.) was about £400, in the 1880s £1 15*s.* and by 1935 about 5*s.* but in 1963 only 3*s.* 6*d.* From the purified bauxite, all of which has to be imported, alumina is obtained by various processes and, using the original Hall and Héroult process, this is treated with cryolite in an electric bath at 1,800°F. (1,000°C.) from which the aluminium is collected in a pure state. It is used alone and alloyed with other metals; one of its most important uses is in cables for high tension electricity, where it acts as a substitute for the more expensive copper. The location of the refining industry near centres of large scale hydro-electric production is due to the fact that to produce one pound weight of the metal requires 42 kWh. (19 kWh. per kg.).

Denmark has neither resources of iron ore nor of fuel and power but has developed a small pig-iron industry since 1944 which helps to maintain the iron and steel manufacturing industry, which was based on scrap and on imports of pig-iron and steel from Britain and Germany. Finland likewise used to depend upon imported pig-iron but now has developed her own smelting industry. Production in the various countries is summarised below.

Production of pig-iron and ferro-alloys and of crude steel, thousand metric tons

	Denmark	Finland	Norway	Sweden
Pig-iron and ferro-alloys:				
1931	—	12	119	418
1938	—	36	174	714
1949	39	99	234	860
1960	73	137	715	1,630
Crude steel:				
1931	—	18	10	539
1938	—	76	67	972
1949	76	111	77	1,370
1960	291	254	489	3,181

(Based on *U.N. Statistical Yearbook, 1951*, Tables 107 and 108; *ibid., 1961*, Tables 106 and 107, *Statistisk Årbog, 1952*, Table 286)

Engineering and shipbuilding

The existence of these home-produced raw materials of the engineering industry has greatly stimulated the latter and exports of engineering products, especially from Sweden, have been considerable. All the Finnish post-war increase for ten years was absorbed in reparations but with the cessation of these the enlarged engineering industry has had to find new outlets. Many of the manufacturers have grown into vast concerns, some from the old handicrafts and some from the manufacture of newer inventions. Varied as the engineering is, there are certain specialisms arising from local conditions:

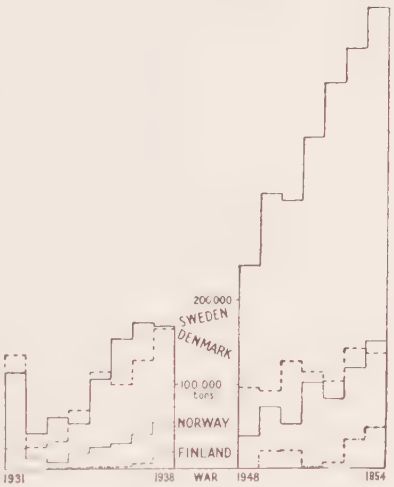


FIG. 152.—MERCHANT SHIPS LAUNCHED, 1931–54.

The great increase of launchings, by gross tons, during this century is a striking feature particularly of the shipbuilding industries of Sweden and Denmark.

Based, by permission, on *Lloyd's Register*, III, etc.

Agricultural machinery	Denmark, Finland, Sweden
Hydro-electric plant; woodworking, pulp and paper machinery	Finland, Norway, Sweden
Shipbuilding and marine engineering	Denmark, Finland, Norway, Sweden
Cement machinery	Denmark
Whaling apparatus	Norway
Machinery for mining and match-making	Sweden

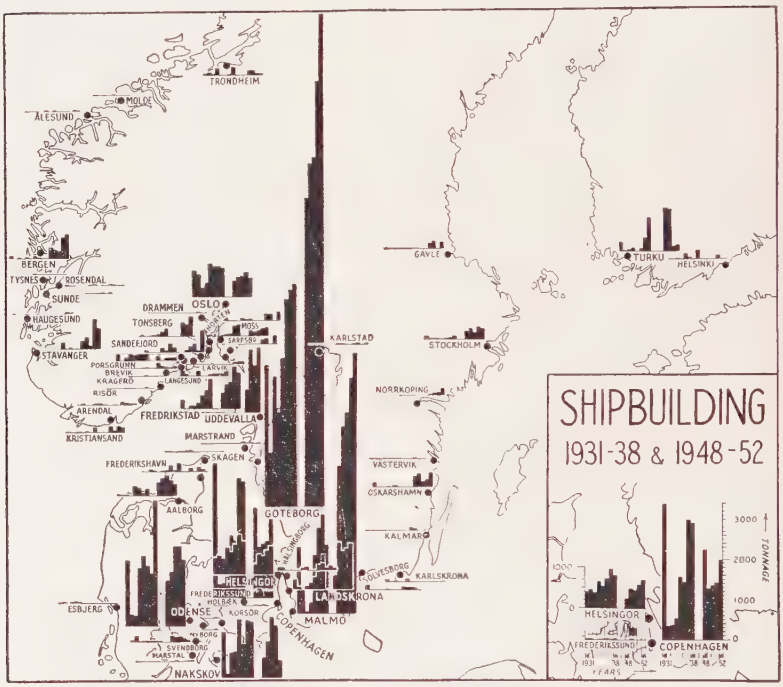


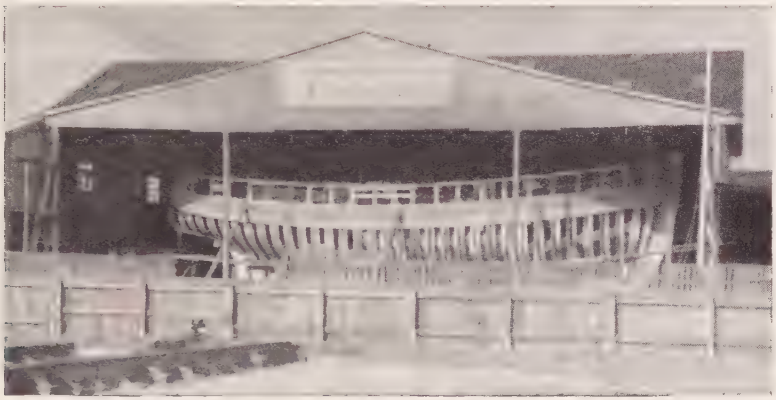
FIG. 153.—LAUNCHINGS AT SCANDINAVIAN SHIPYARDS, 1931–8 AND 1948–52.

Minor yards in Finland and Norway are omitted but otherwise every yard producing merchant tonnage during this period is indicated under the port; if more than one yard exists at a port the tonnages are aggregated for the year. All graphs are to the same scale which is indicated in the inset of the output of the Danish yards near The Sound. The supremacy of Göteborg as the premier Scandinavian shipbuilding centre is clearly seen.

Based on statements of shipyard outputs in the Annual Trade Reviews of the *Glasgow Herald*.

Of the engineering industries one of the most substantial is shipbuilding and the output of the Scandinavian yards is shown in Figure 153. The tonnage of iron and steel girders and plates required is greater than the home production of the northern countries so this industry is not independent of world conditions. The Scandinavian countries have specialised in certain types of craft.

During the inter-war period there was a revival of construction of schooners with auxiliary engines and the sails worked by oil-engine winches; these vessels are of value for carrying lime, sand, timber, paving-stones, glass sand and other commodities in the Baltic and North Sea trades and their revival is in response to the demand for transport on short-sea runs. Several yards have specialised in recent years on the construction of tankers and the size of these has



A.C.O.] [*April, 1953*

FIG. 154.—BOATBUILDING YARD AT ESBJERG.

increased, a development which in Sweden was aided by the construction in 1940 at Göteborg of one of the largest ship-model testing tanks in Europe. Associated with shipbuilding is marine engineering, and the Scandinavian countries are important producers of diesel units, an interest which has grown from the pioneer work of Burmeister and Wain of Kobenhavn. Nowadays practically all ships constructed in Scandinavia are powered by diesel units.

Building materials

In the treatment of quarry products Denmark, with her greater richness in clays and limestones, rivals or outstrips her northern neighbours.

Manufactured building materials

1956	*Million bricks*	*'000 tons Cement*
Denmark . .	520	1,187
Sweden . .	336	2,495
Finland . .	173	960
Norway . .	121	895

(Based on *U.N. Statistical Yearbook, 1958*, Tables 107 and 108)

The significance of these production figures is seen in the buildings and in the export lists (cf. p. 203). In Finland and Norway, which suffered most damage during the war years, the post-war increase of production of these materials has generally been greatest. In recent years Norway has specialised in extra-fine grinding ("micronising") of minerals such as soapstone, mica and dolomite and these products are of value for paint and paper fillers.

Industrial location

The industrial map of Scandinavia shows that despite the apparent scatter of the industrial units there are recognisable geographical influences on the pattern; these are concerned mainly with the supply of raw materials or with the ability to ship the manufactured products. In Finland the major industrial units are found where there is a navigable waterway and a railway close to the coast; the former close dependence upon waterfalls has decreased with the transmission of electric power, and so the individual industrial centres are located without particular reference to power supplies. Many of the industries are "foot-loose" as regards sources of raw materials, and as they are attracted to the populated districts there is a pull to the coast. The most important area is in and around Helsinki but Tampere, situated in a region of water-power, is second. Industries which manufacture for export are principally found alongside estuaries, and as their products are largely based upon wood, the supply of raw material can be floated downstream to the factories.

In Sweden, if isolated electric furnaces such as those at Luleå, Karlsvik and Rönnskär be disregarded, six metal working regions can be distinguished:

i. Gästrikland coast round Gävle and the lower Dal älv.
ii. Bergslagen.
iii. Mälar border.
iv. Stockholm.
v. Väner border.
vi. Göteborg area.

(i) The metal industries have been attracted to the Gästrikland region by the enormous electric power available from the rivers. Sandviken, near Gävle, has a large output of tubes, sawblades, axles and wheel tyres. (ii) In the mining district of Bergslagen are produced ore concentrates to feed the peripheral blast-furnaces with principal industrial centres at the transport nodes: along the Kolbäck valley, canalised since the eighteenth century, is a string of works from Mälar to the heart of Bergslagen. (iii) Round Mälar are important centres including the headquarters of ASEA (Allmanna

Svenska Elektriska A.B.) which is the principal Swedish firm manufacturing electric motors and transformers, turbines and locomotives. (iv) Like most capitals Stockholm has varied metallurgical industries where bulk is less important than the intricacy of the product; here are the principal firms manufacturing telephones, cinema apparatus, primus stoves and so on. (v) Around the shores of Väner, with access to sea navigation and close to timber regions, towns such as Karlstad specialise in the manufacture of pulp and paper machinery. (vi) Sweden's main window to the west, the valley of the Göta älv, has varied metal-working industries, many of which serve not only Sweden but also the world—shipyards, SKF roller bearings, electrical gear, locomotives, sugar-refining plant—to give but a few out of an extensive list. To the north lies the once important granite working district of Bohuslän and to the south the cement centre of Limhamn; near Malmö are the brick and earthenware manufacturing units.

In Norway the industrial districts dealing with metals occur principally near the southern populated centres: they are widely scattered and there is no concentration other than in and around towns such as Oslo, Bergen, Trondheim, Kristiansand South where the labour force exists and there are port facilities to handle the imports of raw materials and to export the finished products.

Denmark has few large industrial firms working in metals but there is a great number of small units: under the Marshall Plan the industrial capacity has been greatly increased. The Danish iron and metal industries have experienced difficulty since the war owing to shortage of power. During the war further plant for producing pig-iron and a rolling mill were established but even so Denmark cannot produce sufficient steel from scrap to cover more than a third of her needs. Much of the industrial activity is established at the ports where the necessary raw materials can be imported; with her dependence upon imports Denmark is thus very vulnerable to world economic conditions. The greatest centre is Kobenhavn, which dominates the Danish industrial economy. At this capital city shipbuilding, marine engineering, light machinery, machine tools and wire manufacture are all important industries.

CHAPTER 19

OTHER INDUSTRIES

There is in Scandinavia a great range of industries, other than those reviewed in the preceding chapters which depend upon home supplies of raw material, and some of the more interesting of these are briefly examined below. Consideration is given to the following groups: textiles, vegetable oils, chemicals, food and drink processing and crafts. The main features of Scandinavian industries are the dispersal of the factories, and because of the frequent need to import either fuel, or some of the raw materials, a tendency to concentration at the ports. Since sections of the coast are liable to ice-closure in winter, there is a tendency to locate such industries at the southern ports to prevent, or to reduce, the liability to interruption of supplies. Such a southern location also places the industries in the more densely settled regions and so gives locally both a labour supply and a market. As all the capital cities are also ports, and contain the largest groupings of population in their respective countries, they tend to be important industrial centres with the usual luxury industries of a metropolis.

TEXTILES

The textile industries of Scandinavia developed from the domestic industries of linen and wool weaving. Two centuries ago vigorous efforts were made, particularly in Sweden, to develop the manufacture of linen, and as a result large quantities of flax had to be imported, for the home production was inadequate. The flax acreage has since declined with the use of tropical and artificial fibres.

Finland needs to import both British and American cotton yarn and Swedish wool yarns as her weaving capacity is greatly in excess of that of spinning. Furthermore, the flocks of sheep produce only about one-quarter of the wool required, a deficiency which is also felt in Denmark and Sweden. For linen production about three-quarters of the flax required has to be imported into Finland from the Soviet Union and from the Netherlands. The growth of the Finnish textile capacity since the war has reduced the imports of piece-goods, a matter of some concern to Britain.

Water-power enabled Finland, Sweden and Norway early to adopt factory spinning and weaving of cotton. James Finlayson, a Scot, founded a cotton mill at Tampere in 1828 and his foresight in the

Textile production, 1931 and 1960
'000 tons

	Denmark	*Finland*	*Norway*	*Sweden*
Cotton Yarn:				
1931	5·3	1·3	1·5	19·2
1960	8·5	18·3	4·9*	25·8
Cotton Woven Fabrics:				
1931	3·5	5·0	1·9	14·1
1960	6·3	13·5	4·4*	22·8
Wool Yarn:				
1931	3·4	0·6	2·8	8·7
1960	4·9	8·0	7·5	13·6
Wool Woven Fabrics:				
1931	1·5	1·6	2·0	7·2
1960	2·5	4·1	4·2*	11·2
Rayon Yarn:				
1931	—	—	—	0·3
1960	—	0·9	0·7	7·8
Rayon Staple Fibre:				
1931	—	—	—	—
1960	—	15·5	13·6	20·1
Rayon Woven Fabrics:				
1931	0·1	0·03	0·01	0·5
1960	0·7	1·3	0·7*	8·9*

(Based on *U.N. Statistical Yearbook, 1951*, Tables 78–84 and *ibid., 1961*, Tables 81–9. Rayon staple fibre is the same as rayon filament but is produced as short staples and then spun. *1959 production)

A.C.O.] [*April, 1953*

FIG. 155.—MILL NEAR VEJLE.

This cotton-spinning mill uses water-power from an artificial lake outfall.

choice of a site is shown by the fact that this is still the biggest textile manufacturing district of Finland. The Swedish textile centre is in the Göteborg region: cotton spinning and textile manufactures commenced here in the early years of the nineteenth century. Norway also was early in the cotton-spinning industry, the first mill being established in 1813. In 1900 nearly half the nation's textile requirements were home produced, by 1938 about three-quarters of the woollen needs, nearly half the cotton and about nine-tenths of the knitted wear were produced in Norway, while by 1948, owing to the expansion of spinning and weaving capacity during and after the war, all the requirements could be produced in the country. In Iceland there are small woollen mills which, however, are unable to satisfy the local demand for textiles.

The wool and cotton textile industries of Scandinavia are supported by considerable imports for even with wool the home production of the fibre is insufficient. The post-war expansion of the wool consumption in the mills is appreciable but in the case of cotton,

Annual wool and cotton consumption, '000 tons

	Cotton		*Wool*	
	1938–9	*1959–60*	*Average 1934–8*	*1960*
Denmark .	8·0	8·9	1·0	1·8
Finland .	13·2	17·8	2·5	3·2
Norway .	3·3	4·6	2·5	4·1
Sweden .	29·7	28·0	5·0	5·2

(Based on *U.N. Statistical Yearbook, 1961*, Tables 127 and 128)

difficulties of supply and of competition from rayon have resulted in the consumption remaining static.

Rayon pulp is produced in several of these northern countries. Finland has a considerable production and this exceeds the demands of the weaving industry.

VEGETABLE OILS

Before the war the Danish milling of oil seeds provided, in oilcake, margarine and soap, nearly a quarter of the industrial exports of Denmark but the supply of raw materials since the war has presented the same major problem as in all the north European countries. Before the war there were large imports of soya-beans, ground nuts, copra and *Sesamum* to keep the refineries fed with crude vegetable oil. The pulp remaining from expressing the oil is used for meal and cake. Half of the production was exported before the war but

since the war the difficulty of obtaining supplies and the need to use home cultivated oil seeds have reduced the quantities available for export. With the shortage of vegetable oils the Danish soap-manufacturing industry has been using larger quantities of animal fat, which marks a reversion to earlier techniques.

CHEMICALS

Consideration of some chemical manufactures has been given on p. 196 and p. 232 but there is an advantage in summarising the relative

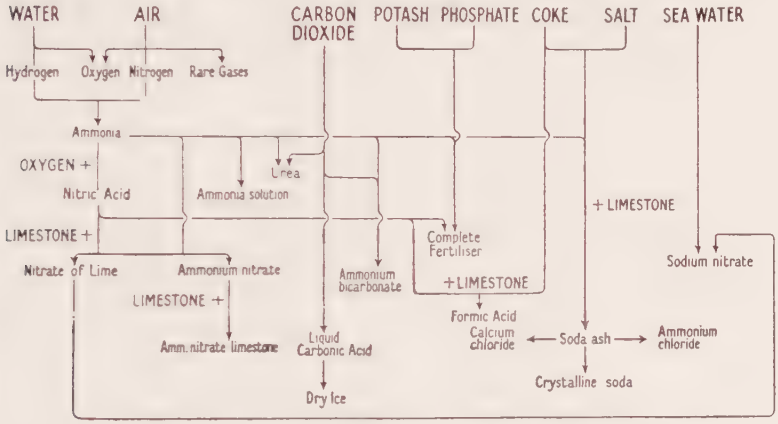


FIG. 156.—PRODUCTION CHART OF ELECTRO-CHEMICALS.
With modifications based, by permission, on *Industries of Norway*, Oslo, 1952, p. 88.

importance both of the countries and of the various chemicals produced. Only Norway produces a full range of these chemicals but in the output of some of them she is out-ranked by Sweden and Finland.

Principal chemical productions, 1958
'000 tons

	Denmark	*Finland*	*Norway*	*Sweden*
Sulphuric acid: (100% H_2SO_4)	13	168	88	403
Hydrochloric acid: (100% HCl)	—	1·7	9·9	35·3
Nitric Acid: (100% HNO_3) .	—	1·4*	18·8	94·1
Caustic soda: (NaOH) . .	3·9	50·4	41·9	153
Soda ash: (Na_2CO_3) . .	—	—	17·8†	2·2
Superphosphates: (% P_2O_5) .	595 (16%)	372 (18½%)	109 (18½%)	491 ?
Nitrogen: (reduced to nitrogen content of calcium and other nitrate, ammonia compounds etc. Year to 30.6.58) . .	—	31·1	244·5	42·9

(Based on *U.N. Statistical Yearbook, 1959*, Tables 94 100: * in 1960, † 1957)

All the Scandinavian chemical manufactures show an increase since before the war, not merely in value, but also when measured by quantity and by the number of workers.

The first factory in the world for the fixation of atmospheric

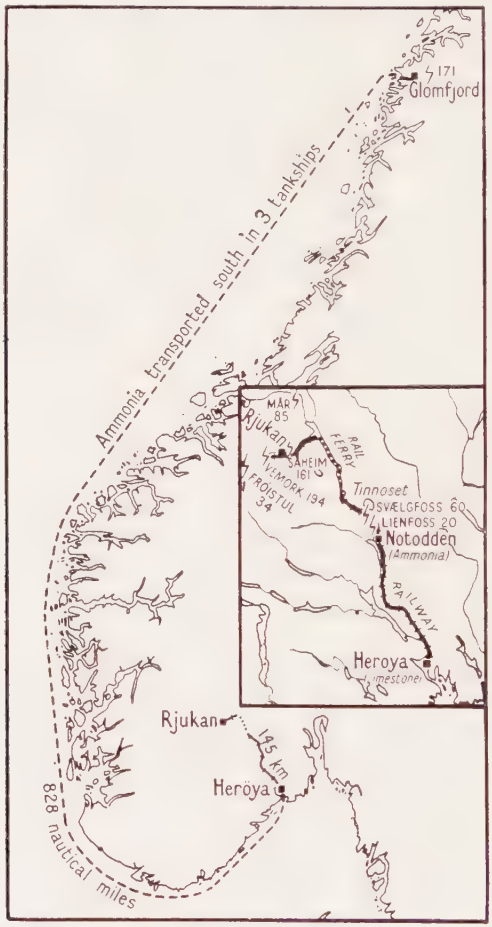


FIG. 157.—MOVEMENT OF MATERIALS TO ELECTRO-CHEMICAL WORKS.

Transport problems can be a major factor in Norwegian industry. Figures on inset are '000 installed H.P. used by *Norsk Hydro-Elektrisk Kvælstofaktieselskab*.

Based on descriptive accounts in *Industries of Norway*, 1952, pp. 84–92.

nitrogen commenced operations at Notodden in 1905 and here, and at Rjukan, Herøya and Glomfjord, one company now produces the equivalent of over a million tons of fertiliser a year from air, water, salt, limestone, phosphate, potash and coke. (See Figure 156.)

Because of the pressing need for fertilisers there is a large import of North African phosphates into Denmark, Finland and Sweden for the manufacture of superphosphates. Hydro-electric power is responsible for the importance of Norway in the field of chemical manufactures and her key position in the preparation of heavy-water resulted in the epic attack during the war on Rjukan; the supplies destroyed at this plant could not be made good from elsewhere. Several of the major chemical industries produce materials required in other manufactures, for example, hydrogen for hydrogenation of of oils and synthesis of ammonia, and chlorine and caustic soda for bleaching cellulose pulp. Colonial possessions are very limited and so there are not many manufactures based on colonial raw materials, but København has a refining plant which handles Greenland cryolite.

FOOD AND DRINK

The manufacture of food and drink from other than home-produced raw materials tends to be concentrated at the ports. In Sweden food-processing is one of the largest industries in the country while in Finland it is the third largest industry by value of production. The range is that of North European countries and only a small proportion is exported although of course it is used towards victualling the merchant fleets.

CRAFT INDUSTRIES

Each of the greater Scandinavian countries has a long tradition of craft industries. In ceramics Finland has the Arabia works at Helsinki, Denmark the Royal Porcelain Factory at København and the Rønne pottery in Bornholm and Sweden, Rörstrand china at Lidköping. Even Iceland has started to develop a pottery industry and is producing work of distinctive character. Glassware of high artistic quality is produced in Finland and by the Orrefors and Kosta firms in Sweden. Crafts also include silverware and wood-carving and these, through the tourist industry, find a wide market. It is probable that through these crafts the Scandinavian countries are better known to the world than from more massive industries such as the manufacture of chemicals. The craft industries reflect the spirit of the northern world, and with clean-cut lines and a certain ruggedness epitomise, to many, the character of the country which they visited on holiday.

FIG. 158.—FIGURINE OF A FÆROESE MILKMAID (*neytakona*).

In this figurine the girl is shown carrying one of the skin-covered pails in which milk is brought from cows milked on the hill pastures.

Photograph by courtesy of Swedish Tourist Bureau] *[Orrefors copyright*

FIG. 159.—KING SOLOMON RECEIVING THE QUEEN OF SHEBA.

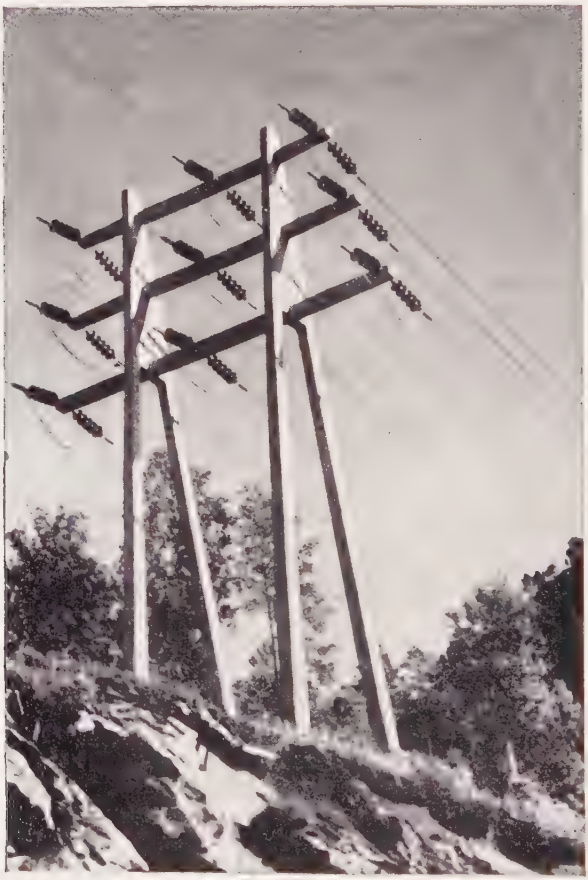
This is a magnificent example of the work of the artistic craftsmen employed by a company such as that of Orrefors, Sweden.

CHAPTER 20

FUEL AND POWER

WATER POWER

All the northern countries except Denmark have favourable conditions for water power development: adequate rainfall (although the run-off is complicated by the winter freeze), rapids and water-falls,



A.C.O.] [*September, 1953*

FIG. 160.—SYMBOL OF POWER, PYLON OF HIGH-TENSION CABLES, NORWAY.

lakes to act as regulating reservoirs, and the industries to consume the power produced. Dams are only needed on a small scale to utilise the run-off more economically. The sites of hydro-electric power development in these countries can be divided into two types: those with a small catchment area upstream of large waterfalls and those with a larger catchment area but low waterfalls. There are exceptions to this division and it is these exceptions, with large catchment area and high falls, such as Rjukan in Telemark, which provide the largest stations. Northern Fenno-Scandia consists of a very low plateau surface and the rivers draining into the Arctic Ocean lack both suitable sites for development and the population to warrant any great exploitation: Kirkenes iron mines have to be fed by a thermal plant. In this northern region shortage of water occurs in the winter when the flow is reduced by freezing, but although the top waters of the lakes do freeze the falls themselves do not become ice-bound and the water can, if necessary, be drawn off by underground flumes. The river régime is, however, exceptionally uneven and it is difficult to secure an even flow of water. Fortunately elsewhere in Norway this is not so, owing to the numerous lakes, and 55 per cent of the power is produced in the winter six months, compared with 30 per cent in Central Europe. With this ability to meet the winter demand Norway has not had to have thermal stations to the same extent as Germany. Over much of the area the terrain is uneven and there are numerous breaks of slope due to interference with the previous processes of erosion by ice. North of 63° N. the rivers which flow eastward come wholly under Swedish control but south of 63° N. Norway has some of the eastward flowing rivers as well as the westward flowing. Those which flow to the west have precipitous falls many of which have been capitalised for hydro-electric supply; falls of over 984 ft. (300 m.) offer three-fifths of the potential power, but as Figure 161 reveals more power is produced on the larger eastward flowing streams. A feature of the seaboard of Norway, where it is more accidented than in other parts of Fenno-Scandia, is the presence of deep fjords near the power sites and this has encouraged the development of industries for which large quantities of raw materials can be easily imported.

Almost all the Swedish hydro-electric installations have low heads of water; the highest is that at Sillre, 645 ft. (185 m.) (cf. Bjölvefoss, Hardangerfjord, 2,820 ft. (860 m.)) but this is quite exceptional for Sweden. The rivers of northern Sweden producing the greatest amount of power are the Indalsälv, Ångermanälv, and Luleälv. Porjus on the Stora Luleälv has a power station once second largest in Sweden, with underground installations to avoid the rigours of winter, it provides power for the northern iron-ore mining and

transport on the Lapland Railway.[1] In southern and central Sweden the rivers radiating from the Småland plateau have rapids where the volume of water compensates for their low height; such

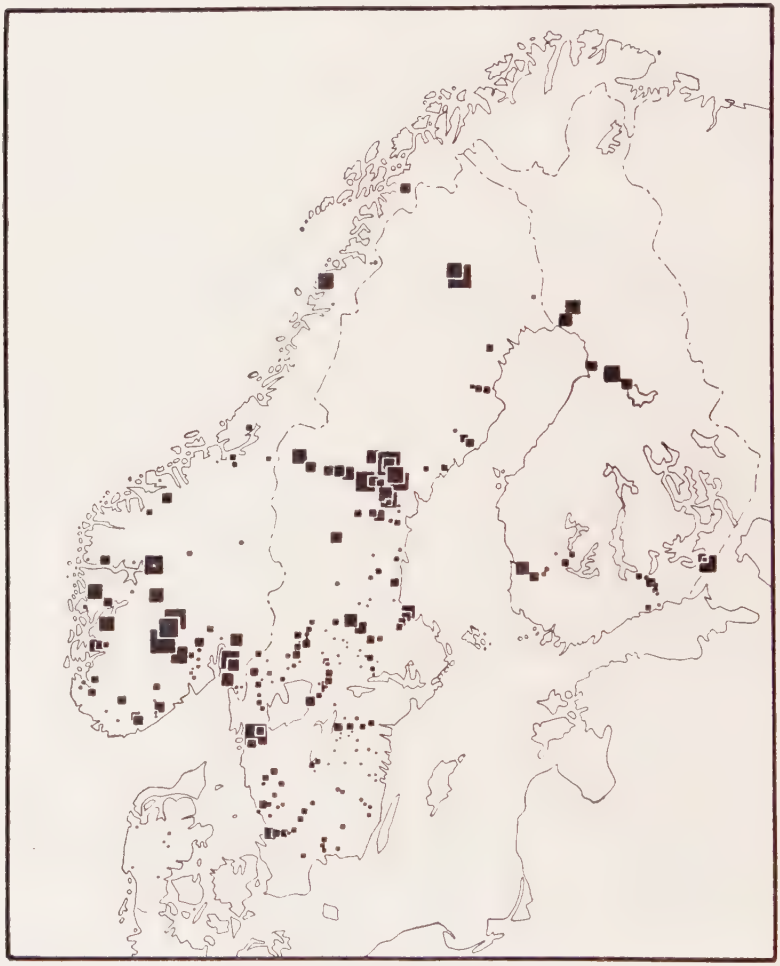


FIG. 161.—POWER STATION SITES, SCANDINAVIA.

The importance of the southern Norwegian, northern Swedish and the Finnish plateau edge stations is apparent.

Based, by permission, on J. Humlum, *Kulturgeografisk Atlas*, København, Vol. 1, 1955, Fig. 127; original map prepared by J. Humlum and A. Krarup Mogensen.

[1] Norway is placing power stations underground wherever possible: partly for defence purposes and partly, as at the Arbjora station in Valdres, because it is cheaper there to provide pressure shafts in rock than in pipe-lines on the surface.

FIG. 162.—MUNICIPAL POWER STATION, BERGEN.

This power station, east of Bergen, is of the normal type. An additional plant has been installed further up the valley, with an underground powerhouse for strategic reasons, which is operated by remote control from this station.

rapids are found on the Motala ström, draining Vättern to the Baltic, and the Götaälv draining Vänern to the Kattegat. On this last river, fed by one of the largest lakes in Europe, is one of the most important installations in Sweden —Trollhättan Power Station, which produces 800–875 million units annually.

Finland has progressively developed her hydro-electric potential since she attained her independence and the State has established the plant at Imatra, on the Vuoksi, which is now the biggest in the country. Unfortunately Finland lacks the flow of water which, per unit area, is half that of Sweden and as little as one-tenth of western Norway while, in place of the precipitous falls of the highland, the rapids are long and gently sloping even on the edge of the lake plateau. The developed hydro-electric power is only one quarter that of Sweden.

The Icelandic rivers have a great potential value for hydro-electricity but as yet there are only twenty stations, five serving Reykjavík and three Akureyri, with the power led in by long transmission lines. The almost complete absence of lakes in the upper reaches of the Icelandic rivers hinders the economic installation of plant. The State is now responsible for electrification.

While many of the water falls and rapids are remote from populated regions the evolution of methods of long distance transmission of current, dating from the first successful experiments to supply Grängesberg mine in 1893, using 3-phase A.C. at 9,500 volts along $8\frac{1}{2}$ miles (14 km.) of transmission line, has brought them into economic exploitation. Nowadays power generated at Krångede, on the Indalsälv, is transmitted to central Sweden and flow of current southwards will increase as further plant is installed to tap the northern rivers. The régime of the southern Swedish rivers, such as the Lagan, exhibits an oceanic influence, with a winter maximum, whereas those in the north have a low water flow in winter; thus the north and south are complementary for grid purposes. The backbone of the Swedish transmission system, which is the most highly organised of any of these countries, is a high-tension line, 400,000 volts, from Lapland to Skåne with major branches to the great consuming centres. The formation of such a grid has been stimulated by the fact that most of the hydro-electric potential of the populated south has already been developed. Norway, with scattered communities and many centres of power generation, has only found it necessary to create an extensive grid in the more densely settled south-east and in the Trondheim area. A serious problem in Norway is the crossing of fjords and other water channels by high-tension wires; across Volda fjord there is a span of 9,432 ft. (2,875 m.). In Finland a grid has been created to link Imatra Power Station with

Turku and Helsinki; by this grid the hydro-electric centres can be coupled with the thermal plant of Helsinki and Turku and so balance the sources of supply.

These northern countries have not yet been completely integrated with an international grid but a start has been made, with lines from Sweden to Norway and to Denmark. From Porjus current is supplied to Narvik along the line of the iron-ore railway. A certain amount of Swedish power is transmitted by three submarine cables, the first of which was installed in 1915, between Hälsingborg and Helsingør to supplement the thermal plant of København; the

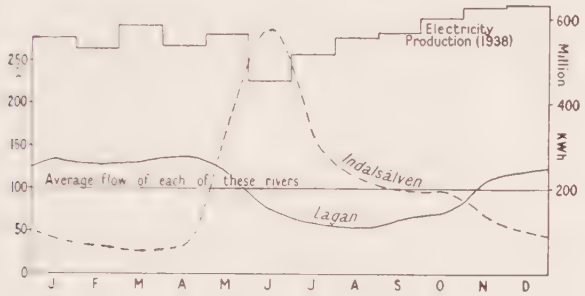


FIG. 163.—ELECTRICITY DEMANDS AND RIVER FLOW IN SWEDEN.

The flow of the southern Lagan, with its summer minimum, and that of the northern Indalsälven, with its summer maximum, are complementary. The monthly flow is expressed as a percentage of the average monthly flow of each: the flows have been, since the measurements, greatly affected by regularisation. The top graph indicates the electricity produced in 1938 by an Association which produces about 85 per cent of the Swedish total. The midsummer minimum is characteristic although the actual quantities produced in each month vary from year to year.

Based, by permission, on F. Hjulström, "The economic geography of electricity", *Geographica*, Nr. 12, Uppsala, 1942, pp. 63 and 111.

flow of current is reversed when the hydro-electric power of southern Sweden is not meeting the home demand because of reduced run-off and increased consumption. Most of the power sent into Denmark is used in Sjælland which is the only part of the country with a well developed grid network. There has been a proposal to construct power lines from Norway through Sweden to Denmark and Germany, and thus use more profitably some of the Norwegian potential. With the rising post-war demand in Norway for electricity this linkage with the south is unlikely to be provided in the near future but in a draft contract with Denmark it was agreed that none should be exported in low water years so the proposal has received some consideration.

Thermal power is not widely used in Scandinavia for electricity

since hydro-electric sources are more economical, as fuel for thermal plant must be imported. In Norway most of the thermal plant is for reserve purposes and the only large operative stations are at Porsgrunn (Heröya nitrate works) and Kirkenes iron works. Sweden has her biggest thermal plant at Västerås which functions as a stand-by station, in conjunction with Värtan and Göteborg, to balance the load, and avoid the necessity of new dam construction, in the central area which is primarily served by the hydro-electric stations of Trollhättan, Älvkarleby and Motala. Steam installations are frequently combined with steam heating. In Finland the thermal stations are also mainly near the seaboard where they can be reached by sea-going colliers and oil-tankers. The richness of the timber resources had made it possible to run a number of small thermal stations on wood fuel but all the large ones are worked by coal or fuel-oil power.

Unlike her northern neighbours Denmark lacks abundant water power and nearly two-thirds of the electricity produced is generated by coal burning stations and one-third by diesel engines. The only large hydro-electric station is at Tange on the Gudenaa, the largest river of Denmark. The main thermal stations are located where the fuel can be readily imported and there is sea or river water for cooling.

Iceland has not great power plant because of the disproportionate capital required for large hydro-electric generating stations combined with the problems of dam construction in porous basalts, and the length of transmission lines which would be necessary to serve the scattered communities. Despite the considerable potential water-power the Icelanders formerly relied on small diesel and wind-driven installations but now considerable hydro-electric constructions serve towns and districts such as Reykjavík and Akureyri.

Water Power

	Norway	*Sweden*	*Finland*	*Iceland*
Economically potential water power, million kW. . .	12·5	6·5	1·3	?
Developed, million kW. 1932	1·7	1·4	0·2	0·003
1960	6·1	9·0	1·6	0·1

In Sweden which has, overall, a high proportion of the utilisable power already harnessed, there are regional differences in the proportion of the potential utilised, for in south and central Sweden, where population and industry are most concentrated, the greatest percentage of the potential is developed. It is easier now to develop

the northern resources and to feed the current southwards than to tap the remaining potential of these southern regions. In Norway the sites most convenient for industry and population have already been developed and future plant installations will demand heavier capital expenditure in either the preparation of the site or in transmission lines: this is one reason why there is opposition to the export of power southwards as it is feared that later installations, for Norwegian use, will be still dearer. Electric heating of homes has become standard in new houses in towns but the demand for power has so out-stripped power-station capacity that this use is restricted at times of low water. Production of electricity per head of population is greater in Norway than in any other country, with Canada occupying second place and Sweden fifth. The significance of this, however, is somewhat doubtful for countries with a large consumption in the electro-chemical industry appear unduly important.

1960 per capita production of electricity, kWh

Norway	8,738	Switzerland	3,564
Canada	6,399	U.K.	2,609
Luxembourg	4,662	Finland	1,962
U.S.A.	4,655	U.S.S.R.	1,363
Sweden	4,652	Denmark	1,131

(Based on *Statistisk Årsbok för Sverige, 1962*, Table 463)

Norway has the cheapest electricity in the world: power costs are half as much again in Canada and Sweden and double in the U.S.A. where one kWh costs $3\frac{1}{2}$ cents to produce.

Power development in the Scandinavian countries has been undertaken concurrently by the State, local authorities and private enterprise. About one-tenth of Norwegian power is produced at State plant and one-third at local authority stations. The great proportion of private production in Norway is due to the huge demands of the chemical and metallurgical industries which generate their own power and consume two-fifths of the current. The State grants concessions and ultimately all the private plant will revert to the Crown. In Denmark only about one-third of the power is produced by privately owned plant and in Iceland all the larger stations are publicly owned. Of the Swedish output about 40% is owned by the State in its capacity of riparian landowner. The Swedish plant, whether nationally, locally or privately owned is interlocked together for grid purposes irrespective of the ownership of the producing units.

Some industries are completely electrified - the Lapland ore-mining, the manufacture of cement and porcelain, the quarrying of

stone, the manufacture of pulp and paper, and the milling of flour—while others, such as sawmills, with waste as a source of heat, still use steam power. One difference between Sweden and her western neighbour is that in Sweden the power is often generated away from the consuming centres whereas in Norway the factories, consuming great quantities of electricity, are near the power stations. This reduces the transmission losses and gives cheaper power. Unfortunately the seasons of peak demand and peak potential do not balance: during the summer when the water is flowing most freely consumption is at a minimum. It is a matter of regret that electricity cannot be stored, for the greatest lighting demands in the north coincide with the peak of the industrial demand for power.

COAL

The coal resources of the Scandinavian World are extremely limited and the deposits are, with one exception, restricted and of poor quality.

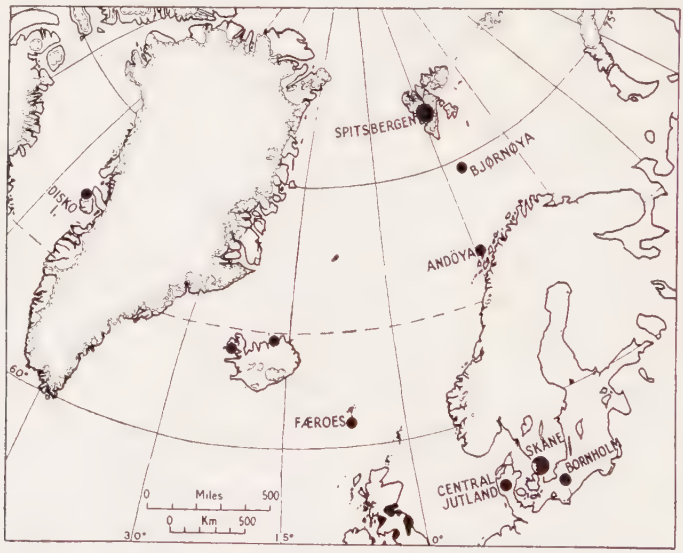


FIG. 164.—COAL AREAS.
Circles indicate Scandinavian coal deposits—including lignite—which have been worked at various periods.

Denmark

Poor coal[1] of Rhætic-Liassic age is found in Bornholm; during

[1] It is estimated that 3½ tons of Bornholm coal have the heating value of less than 2 tons Newcastle coal.

Coal Analyses

Geological age	*Estimated reserves. Million tons*	*Location*	*Percentage of:*					*Calorific value*
			Carbon	*Sulphur*	*Combustible volatile matter*	*Moisture*	*Ash*	
Miocene	—	Jylland (Sandfeldgard)	46·9	3·6	?	20·0	5·4	*c.* 3,700
Rhætic-Liassic	—	Bornholm (Hasle)	48·0	?	?	24·3	10·2	*c.* 3,200
Jurassic	100–300	Skåne (Höganäs)	55·54	0·91	?	10·1	17·52	*c.* 7,700
Upper Jurassic	—	Andöy	—	—	—	—	—	—
Tertiary	?	Spitsbergen—Tertiary	81·5	0·7	33–40	?	2·5	6,700–8,000
Lower Cretaceous	1,500	—Cretaceous	76·0	1·5	21–35	?	7·5	6,700–7,600
Lower Carboniferous	1,500	—Carboniferous	75·7	0·48	21–39	?	10·0	7,000–7,600
Devonian	?	—Devonian	—	—	—	—	—	—
Carboniferous	—	Björnöya (Bear Island)	—	—	15–19	—	14	7,100–7,300
Upper Devonian								
Tertiary	50	Færoe—						
		Kvalbø anthracite	60·9	?	?	12·2	1·5	6,200
		Trangisvaag slate coal	46·6	?	?	18·8	16–48	?
Tertiary	—	Iceland (Skaroströnd)	34·8	8·9	28·0	13·2	15·0	4,421
	—	Greenland	—	—	—	—	—	—
	—	European lignite	59·0	?	24·7	10·3	6·0	5,300
Carboniferous	—	Scottish coal	89·0	1·0	7·5	?	4·5	8,000

the last 80 years this has been mined only sporadically, when other sources of supply were too expensive or unobtainable through war. Three collieries between Rønne and Hasle each produced annually about 2,600 metric tons before their closure in 1868, 1876 and 1880 respectively. The thin seams of sulphurous coal are overlaid by porous sandy beds up to 60 m. thick and this makes the workings wet. Lignite of Miocene age is found in central and western Jylland over an area of about 1,900 sq. miles (5,000 sq. km.) and during the Second World War the deposits were worked on a large scale near

A.C.O.] [*April, 1953*

FIG. 165.—DANISH LIGNITE AT FISKBÆK.

Since 1936 this lignite has been quarried for the manufacture of briquettes. Problems include the ever-increasing overburden and the water content of 40 per cent which has to be reduced to 10 per cent before manufacture.

Herning, for briquette manufacture: the output exceeded $2\frac{3}{4}$ million tons a year in the immediate post-war period but has since declined. The high ash and sulphur content spoil the coal for general consumption and an attempt to work it at Silkeborg in 1861 was stopped after it was found to be very friable.

The relative heating value and costs for a pre-war year are summarised in the following table from which it can be seen that unless the brown coal briquettes, or the peat, can be produced very cheaply they are expensive fuels and only in time of war is their production justified, particularly in view of the agricultural land lost in removing

the overburden from the lignite. In the case of the peat there may be reclamation of land to justify the expense of the fuel in relation to its calorific value.

Relative fuel prices, 1938

Fuel	*Calorific value*	*Price in Kroner per metric ton*	*Price in øre per 1,000 heat units*
Peat	3,440	22	0·64
Lignite briquettes (Viborg) .	4,616	46	1·00
,, ,, (Sønderjylland)	4,616	32	0·69
Imported coke . . .	7,129	54	0·76

(Based on F. Thørgersen, Tilvirkningen af Torv, *Hedeselskabets Tidsskrift*, Nr. 1, 1939, Viborg)

Sweden

The only coal in Sweden is Jurassic coal, found in Skåne over an area of some 300 sq. miles (800 sq. km.). The field contains some 100–300 million tons of reserves of a coal of 13–35 per cent ash content, in horizontal or gently dipping, but much faulted, seams up to one foot thick. The most important district is Höganäs-Billesholm which contains all the recently worked mines. The coal-bearing formations consist of sandstones, shales and clays. Most of the mines were shallow, the deepest being 354 ft. (108 m.) at Höganäs. Fortunately a high grade fireclay, of use for pottery, drain-pipes and bricks, accompanies the seams and makes the working economically feasible. Mined since the sixteenth century, this coal supply only meets about three weeks' Swedish requirements of coal. The mines are, however, invaluable for the local clay-using industries of Höganäs and Billesholm. For many years the coal output had remained at just over one-third of a million tons annually. During the war years production was increased to a peak of 615,000 tons in 1945 but it has now declined to 250,000 tons. The Scanian mines supply the Swedish railways with considerable quantities of fuel, but the demand for locomotive coal is decreasing as more lines are electrified, and thus the coal is freed for industrial purposes.

Norway

The only coal found in Norway proper is on the island of Andøya (Vesterålen group) in a small area of one square mile (3 sq. km.) of Upper Jurassic rocks let down into the Archæan rocks by faulting. These deposits of cannel coal of high ash content, no less than 50 per cent, are difficult to mine and are not in fact worked.

Svalbard

As early as the seventeenth century whalers mined Spitsbergen coal for their own requirements. The islands were for long a no-man's land, and are not yet properly surveyed, so the reserves are difficult to assess with accuracy. Most of the known coal lies on a plateau and there are three main coal-bearing formations. The Carboniferous coal, in thick seams, is hard and shaly but has a considerable calorific value. The Jurassic coal is not so useful as it contains interfoliated shales and the seams are thin. Near the base of the Tertiary deposits is a workable seam, in places 10 ft. (320 cm.) thick, and as it is accessible and of good quality this has been the basis of the coal industry. The seam dips at a slight angle and a constant temperature is soon reached a few degrees below freezing point. The ground is frozen to a great depth and this prevents water percolating into the mine and so limits gas formation, the rotting of pitprops and falls of the roof. Mining is possible throughout the year. The coal is transported to the vessels or storage bins by aerial ropeway. The construction of the quays was difficult owing to sea-ice pressure and the shipping season is only some four months, from June to October. Unfortunately for the north Scandinavian iron-ore industry, the Spitsbergen coal does not produce a good metallurgical coke: this is particularly to be regretted as it is nearer to Narvik than are the coal exporting ports of north-east England. Certain charges such as insurance, labour and food costs and freightage (for there is virtually no return cargo) were high but there were no taxes, mining or harbour dues for until 1920 it was a no-man's land. Spitsbergen can supply one-tenth of the Norwegian requirements. During the 1914–18 war a Swedish company was mining coal here but in 1918 it failed, on account of shipping difficulties, to send the 50,000 tons required and the Swedish interests were sold to a Norwegian Company. The Russians and Norwegians are still actively engaged in mining this coal (see p. 289, *et seq.*). Production ceased in 1941 but was resumed in 1945; from the Norwegian and Russian mines 716,295 tons was taken in 1961 and from the Norwegian in this year 370,000 tons. A Norwegian company was exploiting in 1919 the small deposit of coal on Bear Island, which gave a good metallurgical coke, but loading facilities were poor, for it was difficult to construct a harbour.

Færoes

As early as 1670 coal was known on Suðuroy in the Færoes and it has been worked for many years. The coal seams, which lie between basalt layers, dip northwards under the sea and are generally thin; the thickest aggregate of the 3 seams is $6\frac{1}{2}$ ft. (1·98 m.). The

reserves have been estimated at 50 million tons. About 1930 a Danish company was formed to work the deposits more actively after a long sequence of State and private endeavour. The coal is of two types; one a slaty lignite and the other a glossy parrot coal (anthracitic) which is found as streaks or kidneys in the seams. Locally the

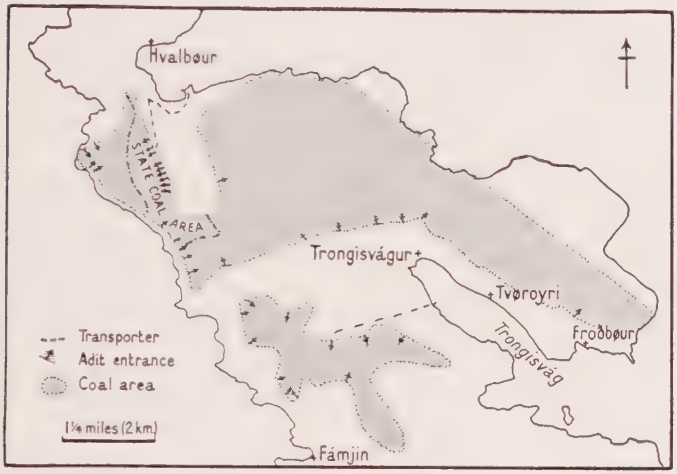


FIG. 166.—COALFIELD ON SUÐEROY, FÆROES.

The coal area is shown with an indication of the various entrances which have been made. The routes down to the waterfront are indicated by pecked lines.

Based, by permission, on F. E. Raaschou, "Om kulforekomsterne paa Færøerne", *Ingeniørvidenskabelige Skrifter*, B. No. 17, København, 1937.

coal has been coked by later lava flows. Tertiary coal also occurs in thin seams on Mykines and as small patches on Tindhólmur. In 1936 the annual coal consumption in the Færoes was about 15,000 tons but as much of this is for steam-raising in ships, for which the local coals are unsuitable, coal has continued to be imported.

Iceland

Lignite is found in Iceland between basalt layers as in the Færoes. The seams are thickest and most frequent in the north-west peninsula, but thin layers of carbonised wood are found in patches over the whole of Iceland. Several unprofitable attempts have been made to work this material for local use, particularly in the north-west, but the high sulphur content is a disadvantage.

Coal is mined on the west coast of Greenland but the working is handicapped by the exposure of the shipping point.

A.C.O.] [*July, 1953*

FIG. 167.—ADIT MINE IN TERTIARY COAL AT TRANGISVAAG (TRONGISVÁGUR).

This mine is situated at the end of the transporter (Fig. 166) and is situated on the hillside on the far side of the fjord shown in Fig. 18). Note the overburden of fine glacial material.

OIL

The only suggestion of the presence of petroleum in Denmark is natural gas found in north Jylland round Frederikshavn. There are considerable Silurian shale deposits in southern Sweden and when Sweden became isolated during the war, plant was installed to increase the production of shale oil. The industry has experimented

with electrical heating of the shale beds to produce oil in order to supplement supplies from normal distillation. As the Swedish shales only contain 5–7 per cent oil, compared with 20 per cent in some other countries, supplies from this source can never be an economic proposition and only the exigencies of war conditions can justify attempts to produce oil.

PEAT

Peat has been used from time immemorial in lands lacking timber and coal for fuel. In Denmark, peat is found in beds up to 33 ft. (10 m.) thick. By means of portable plant the peat is macerated to increase the rate of drying, and is pressed into briquettes, the use of which has rapidly increased. A further advantage of the widespread use of this peat is that land is at the same time being reclaimed for

A.C.O.] [*August, 1938*

FIG. 168.—PEAT WORKINGS IN ICELAND.

Peat workings are not common in Iceland but much turf has been cut, in the past, for wall building.

agriculture. Peat has also been worked for fuel in Sweden, and during the 1914–18 war when coal was in short supply it was even used for firing locomotives. In Finland abundant firewood supplies reduce the need to work the extensive peat deposits. Peat occurs in beds up to 20 ft. (6 m.) thick in Norway and is cut and prepared by machinery for fuel.

The Færoes and Iceland also contain thin, but valuable, beds of peat. The lowlands and valleys of Iceland have widespread deposits, and peat is extensively dug for fuel, although the thickness

seldom reaches 13 ft. (4 m.) and it may contain blown sand and volcanic ash.

FUEL TRADE

Lacking suitable coal deposits and oil, the Scandinavian countries have found it necessary to import both in considerable quantities. Though electricity and timber can be obtained in quantity from the countryside, they do not altogether obviate the necessity of such imports.

Each of the Scandinavian countries imported coal and the imports into Norway for 1938–9 may be taken as representative of the pre-war period; since the war the imports have been drastically reduced.

Coal including bunker	2·3 million tons of which:	Railways etc.	0·22
		Gasworks	0·12
		Bunker	0·63
		Household	0·29
		Industry	1·03
Coke and cinders	0·7		
Total	3·0		

Of the 1·03 million tons used in industry 47 per cent was employed in the wood-using industries and 13 per cent in electro-metallurgy. Most of the import of coal into Norway came from Great Britain, but Poland and Germany were both appreciable suppliers and some came from Spitsbergen.

Of all the imports into the northern countries solid fuel forms the largest single item, by both weight and value, and fuel oils second: in 1935 France alone exceeded the northern countries as an importer of coal. Under the terms of the trade agreements made in 1933 between the Scandinavian countries and Great Britain, in an attempt to ease the economic situation, the former had to buy an agreed percentage of their coal imports from Britain, and this resulted in a decline in the quantities imported from Germany and Poland to about 37 per cent.

Imports of coal and coke, etc., 1935 and 1959, thousand tons

	1935		*1959*	
	Coal	*Coke, briquettes*	*Coal*	*Coke, briquettes*
Denmark	3,890	1,420	2,854	1,144
Finland	1,015	207	2,564	284
Sweden	5,254	1,747	1,760	3,275
Norway	2,182	1,899	267	877
Iceland	139	1	30	32

(Based on *U.N. Yearbook of International Trade Statistics*, 1954, etc.)

The second largest of the import items, fuel oils (including petrol), owes its importance to the extensive use of the motor vehicles in the scattered communities which characterise so much of Scandinavia; in Europe only France and Britain exceed Denmark and Sweden in the number of motor cars per thousand inhabitants. Further, diesel and other crude oil engines are widely used for small thermal electric stations, for railcars and for fishing vessels. The principal suppliers of the refined liquid fuels are the U.S.A., the U.K. and the U.S.S.R.

ENERGY CONSUMPTION

Ignoring the vegetable sources of heat, there are available estimates of the energy consumed from coal, petroleum and hydro-electricity in the various countries (*U.N. Statistical Yearbook*, 1951, Table 125 and *ibid.*, 1961, Table 120) and this energy expressed as a coal equivalent of metric tons per inhabitant shows the increasing use of energy, much of it in industry. It would appear that timber has not

Coal equivalent[1]*: metric tons per inhabitant*

	1929	*1937*	*1949*	*1950*	*1960*
Denmark .	1·62	1·72	1·70	2·09	2·82
Finland .	0·58	1·03	0·92	1·17	1·64
Iceland .	1·77	1·86	2·99	2·59	3·64
Norway .	3·71	3·44	3·93	4·37	2·73
Sweden .	1·82	2·50	2·82	3·22	3·50
U.K. . .	4·11	4·28	4·30	4·42	4·92
U.S.A.. .	6·57	5·78	7·26	7·74	8·01

been considered in the fuels consumed, for it is difficult otherwise to account for the low consumption *per capita* of Finland as compared with Iceland. This table is a striking commentary on the value of developing hydro-electricity and, in view of the limited coal and oil resources, on the vast import traffic which takes place into countries such as Denmark in order to maintain their economy.

[1] The Statistical Office of the United Nations has taken a factor equivalent of coal: 0·9 for coke, 0·33 for lignite, 1·3 for crude oil, 1·5 for motor spirit, 1·67 for bottled gas. As equal to 1 metric ton of coal 600 cu. metres of gas and 1,670 cu. metres of natural gas. Electricity of 1,000 kWh = 0·9 metric tons (1927) of coal, 0·7 metric tons (1937), and 0·6 metric tons (1949–50), a decline resulting from increasing efficiency of thermal plant. For the 1958 conversion figure allowance is also made for the energy loss in dynamos and so 1,000 kWh is equated with 0·125 metric tons of coal; this mainly accounts for the decline in Norway, Sweden and the U.S.A. 1950–58.

CHAPTER 21

TRANSPORT

Although handicapped by sparse population and by great distances, the people of the Scandinavian World have developed a transport network which may appear open compared with the intricacy of that in Britain but is nevertheless adequate for the commercial, industrial and tourist demands. In such a harsh environment the construction and operation of transport lines is difficult, except in the gentler south of Scandinavia, and the capital costs imposed are heavy although the mileage of routes may appear slight. A measure of the burden of large area and of low density of population may be obtained by assessing the railway mileage of 1938 against units of area and of population:

Relative railway mileages

	Length per		*Length per*	
	'000 sq. miles	*'000 sq. km.*	*'000 inhabitants*	
	miles	*km.*	*miles*	*km.*
Norway . . .	21·8	13·5	0·76	1·22
Finland . . .	24·8	15·5	0·73	1·77
Sweden . . .	51·8	32·2	1·2	1·93
Denmark . . .	160·0	99·9	0·58	0·94
Great Britain . .	197·5	123·3	0·35	0·57

(Based on *Statistisk Årsbok för Sverige, 1962*, Table 478)

From this table it can be seen (i) that the railways of Britain have a smaller mileage per thousand persons, in other words for a hundred miles of route there are more potential customers, and (ii) that the network is closer in Britain. Sweden has constructed most freely of any country in Europe in relation to her population but the relative burden, as compared with that of Great Britain, is not so severe as it would seem, since the cost per mile was much less.

Scandinavia has been afflicted by the scourge of variety of rail gauges, for no less than nine different gauges are employed. At Växjö in southern Sweden there is a remarkable station where lines of three gauges meet.

Scandinavian rail gauges

	mm.	*ft. in.*		*mm.*	*ft. in.*
Norway: .	1,435	4 $8\frac{1}{2}$	Sweden: .	1,435	4 $8\frac{1}{2}$
	1,067	3 6		1,093	3 7
	1,000	3 $3\frac{3}{8}$		1,067	3 6
	750	2 6		891	2 11
Denmark .	1,435	4 $8\frac{1}{2}$		802	2 $7\frac{5}{8}$
	1,000	3 $3\frac{3}{8}$		600	1 $11\frac{5}{8}$
			Finland .	1,524	5 0

Relief of the land has, as elsewhere, affected surface routes. In the deep-cut glaciated valleys, which frequently end in culs-de-sac, the construction of through roads and railways is difficult, and this problem is most severe in western Norway in passing from the main fjord valleys to the hanging valleys or on to the fjell. The few railway routes have to tunnel into the hillside as they make the grade by striking obliquely up the side of the valley, while the roads have numerous hairpin bends. So acute can this problem be that sæter pastures frequently have wire ropeways to slide the churns down to the main valleys. The small amount of road construction in north-west Iceland is partly due to the steepness of the slopes. In Sweden there is not the same problem but relief still exercises control, for several of the main routes in Norrland have to strike across the incised south-eastward-flowing rivers and this necessitates heavy bridging. In southern Sweden, Denmark and Finland control by relief is not so severe, and its effect is felt in detail more than in general alignment.

Water-bodies handicap land transport: in Iceland the large fluvio-glacial estuaries on the south-east coast are difficult to cross and impossible to bridge, in Norway the fjords are too deep and broad to bridge, in Finland the large and numerous lakes deflect the roads and railways and in the Danish archipelago the channels between the islands interrupt transport routes. The Finnish lakes would present a bigger obstacle than they do, but for the long esker ridges which provide natural crossings. Bridging has been attempted here but the wealthier countries of Denmark and Sweden have been able to construct more imposing structures; for example, the Storstrøm bridge linking Sjælland and Falster, 2 miles long (3,211 m.) is the longest bridge in Europe, while in Sweden there is the magnificent bridge over the Ångermanälv used by the Inland Railway.

Climatic conditions offer difficulties in operation. At the freeze and the thaw the dirt roads are at their worst for traffic and the best

conditions are in winter when the ground is firm, although wheeled vehicles find difficulty compared with sleighs or sledges. Snow handicaps the operation of the railways, particularly on the Bergen to Oslo line which crosses the fjell. Ice handicaps the handling of the iron ore on the Narvik line, and special apparatus has had to be installed to loosen the ore, which freezes to a solid mass. The inland waterways are, of course, closed by ice and the placing of the logs into the "floatable" rivers has to be delayed until the ice has gone, otherwise the logs would be crushed.

A survey will now be given of the principal media of transport in the various countries to show the relationships of the terrain and the conditions to construction and operation.

ROADS

The road pattern of the Scandinavian countries is of interest, because it ranges from the very open network of the north to the close reticule of the south. Each of the countries which possesses roads has a better network in the more settled south; a sample of the road-pattern is given in Figure 169. When considering this map it is necessary to bear in mind that the standard of roads varies tremendously, both in construction and maintenance, and the capital cost of a mile of road in the south may be much greater than a mile of road in the north but, against this, the northern road, with lack of alternatives, may have intrinsically valuable traffic flowing on it and without it life would indeed be very difficult. Local differences can also be seen from the map: for example, the heaths of Jylland have a more open pattern than the other areas of the peninsula.

The various State authorities have long interested themselves in the construction of roads in order to avoid the disruption to communications liable to occur with water routes. In Finland the two oldest inland roads of any length are the summer road from Turku to Viipuri, constructed in 1293 for Swedish troop movements, serving as an artery between Sweden and Russia and the Hämeenlinna Ox Road from Turku to Häme which was probably constructed during Birger Jarl's crusade of 1249. During the succeeding mediæval period, roads and bridges were constructed in Scandinavia and inns established, but the first organisation of national roads was built up by Gustavus Vasa who extended control over Finnish roads after his visit in 1555–6. Many of these were then developed as portages linking navigable waterways and were only of value during the summer. Although routes went towards Karelia for fishing and trading, Gustavus Vasa compelled the destruction, for military reasons, of a number of roads in the Finnish-Russian border zone.

Later centuries saw a more liberal policy and roads were constructed to improve agriculture and trade.

The coming of railways profoundly modified the flow of road traffic in the districts where they were constructed: the trunk roads lost much of their significance while road links which could serve as

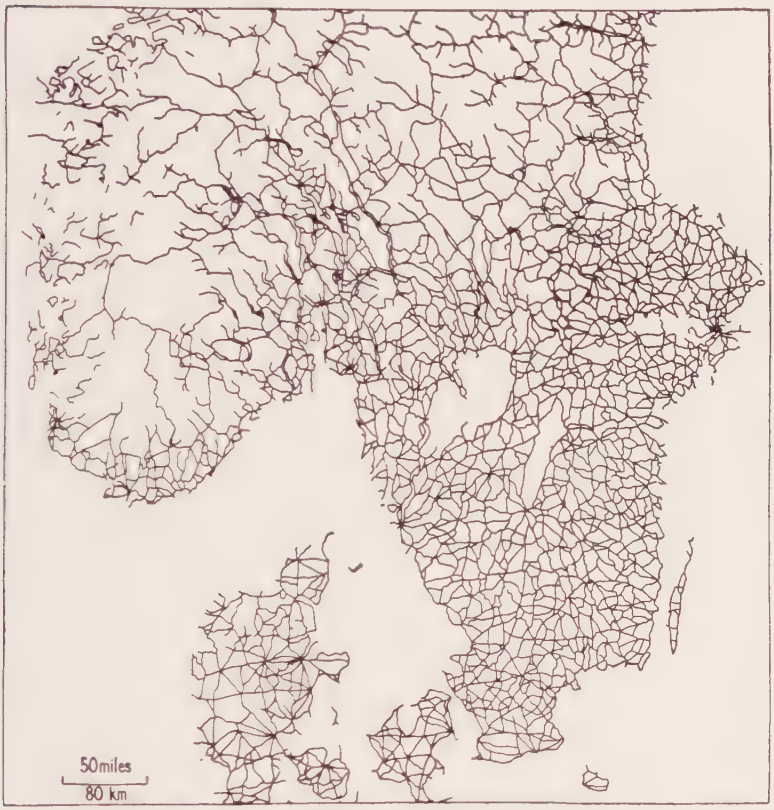


FIG. 169.—ROAD PATTERN OF SOUTHERN SCANDINAVIA.

Note the thinning out of the reticule northwards from southern Sweden and Norway as well as westwards into Jylland. No coastline is given on this map.

Based on various road maps.

feeders to the railway stations became important. But there still remained at the beginning of the twentieth century vast areas served only by trails or bridle paths, and road construction still continues in northern Scandinavia. In Norway, in the high fjell country and the north roads are still few and the network is incomplete.

After the First World War conditions were dramatically changed by the use of the motor vehicle and by 1923 the road was acquiring its modern value. The earlier trunk roads, though excellent for horse transport, had to be reconstructed on better foundations with an all-weather surface, corners and gradients had to be eased and by-pass roads provided round urban centres. In Finland a trunk road scheme was adopted in 1933, by which new roads suitable for fast traffic were constructed away from the railway routes and, as a result of vigorous road construction by the government and by the villages, the country has now 61,000 miles (94,000 km.) of motorable roads of which 6,323 miles (10,117 km.) are trunk highways. Unfortunately, in Northern Finland, as in Finmark, much of the post-war energy has had to be devoted to reconstruction following German destruction of bridges and culverts. After many years the trunk road from Oslo to Kirkenes was opened in 1941. Denmark has not experienced the same difficulties in road construction from relief, although the fjords and islands require long bridges or ferries to complete the network, but she suffers from the lack of suitable road metal: paved and concrete surfaces have been adopted.

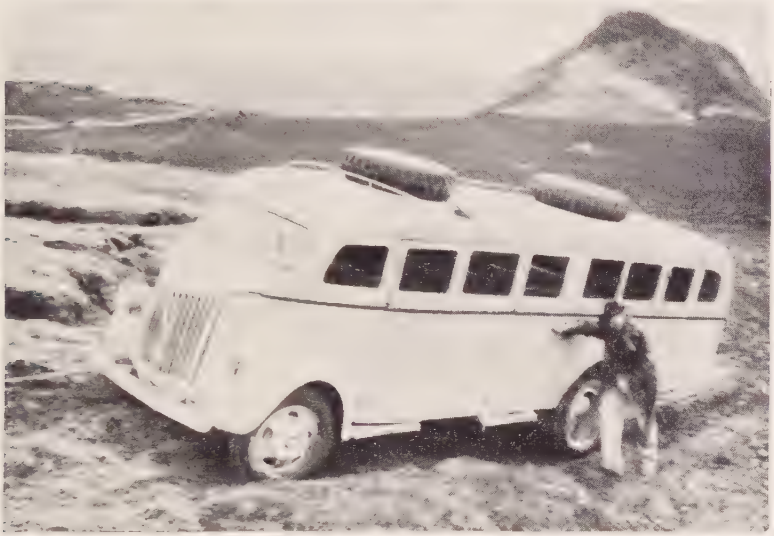
Avoidance of marshy areas is seen in south-west Jylland and in southern Finland and the roads run on drier moraines. The problem of steep gradients is found most in Norway, and one of the most dramatic roads is that joining Myrdal station to Aurlandsfjord; this road, which was built in 1895–6 to carry materials from ships in Sognefjord for the Oslo–Bergen railway has 27 hairpin bends and has never been available to motor traffic, the only vehicle allowed being the horse-drawn *stolkjære*.

Until the 1880s road transport in Iceland was limited to trails or bridle roads and wheeled vehicles could not be used without bridges or a track across the rough terrain. Bridging was a major difficulty in view of the wide rivers; suspension bridges and girder bridges have been constructed, but since 1907 concrete has been the favoured medium. The roads vary greatly in quality—from a concrete surface to a rough track marked by cairns—but during the Second World War many roads were improved to meet the needs of the occupation forces.

An obstacle in keeping the roads open is snow, and whereas the horse-drawn vehicle could pass, the motor needs the roads to be cleared by snow ploughs. In Iceland, except in the south-west, roads are liable to closure particularly during the late winter. Severe frosts damage macadam surfaces and gravel gives a better surface. Because of the difficulty of using snow ploughs the maximum gradient allowed in Norway is 1 in 12 and to attain this on the edge of the fjord valleys tunnels and embankments are used in the

layout of the roads. Snow and stone avalanches have to be guarded against on some sections of mountain roads, while snow fences are placed on the fjell sections.

With the use of motor-vehicles, it is possible to provide a more efficient carrier service and to open up the country by rural bus services. These frequently radiate out from the railway stations and this is best seen in the mailcar services running inland from the



A.C.O.] [*July, 1956*

FIG. 170.—ICELAND BUS SCENE.

A bus unable to surmount, unaided, a rise on a side-road in the lava region of the Reykjanes peninsula of south-west Iceland.

stations of Nordland—a pattern similar to that in the Highlands of Scotland. Road transport in Iceland has developed considerably but the poor road surfaces of gravel and grit lead to increased difficulty in maintaining the vehicles as well as in driving. There is still a considerable dependence upon the Iceland pony for pack-transport and haulage. With State Railways the State authorities have frequently been compelled to participate in the operation of road services. The use of motor vehicles has greatly increased as the table on p. 482 shows.

The extension of road transport has greatly reduced rail-traffic receipts, as in many other countries. In the northern regions the road services were complementary to rail whereas in the more densely populated south they were rivals. In Norway there has

Road vehicles in Scandinavia

	Passenger vehicles (thousands)		*Commercial vehicles (thousands)*	
	1932	*1960*	*1932*	*1960*
Denmark	83	408	34	169
Finland	23	183	12	72
Iceland	0·6	14	1	6
Norway	30	225	22	112
Sweden	102	1193	43	130

(Based on *U.N. Statistical Yearbook, 1958*, Table 137, and *Statistisk Årsbok för Sverige, 1962*, Table 479)

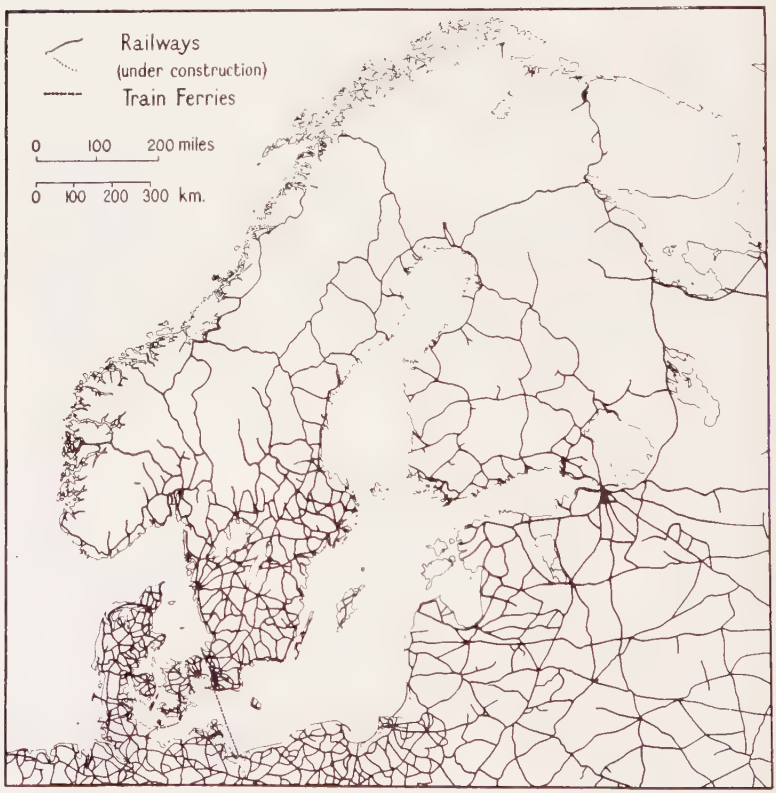


FIG. 171.—RAILWAYS OF SCANDINAVIA.

Notice the intricacy of the reticule in the southern area and the more open network of Norway, northern Sweden and Finland.

been a considerable degree of co-operation between the two transport agencies but in all the Scandinavian countries this competition resulted in improved rail facilities. Co-ordination of these transport groups is complicated by the shipping interests which disturb any single plan for the complete control of transport services.

RAILWAYS

The provision of railways was delayed in Scandinavia by shortage of capital and by the prospect that, without developed industrial resources, the financial returns would be slight. Railway construction has not been cheap, even with all economies possible, because of

FIG. 172.—RAIL COVERAGE.

This diagram emphasises the areas more remote from rail services. For certain cities the approximate area which can be reached within one hour by passenger train is indicated while open arrows show certain bulk traffic flows. For comparison Scotland is inserted.

the physical conditions of large rivers and dissected plateaux. Thus construction was late in starting and lines were first opened in Denmark in 1847, in Norway in 1854, in Sweden in 1856 and in Finland in 1862.

All four of the Scandinavian countries with railways have State systems. In Sweden the main lines were regarded as being the responsibility of the State but the lines of local interest were left to private enterprise: in 1932 40 per cent of the mileage was State owned but now a considerable further mileage has been nationalised; by 1948 85 per cent was nationalised, and railways form the largest business undertaking in the country.

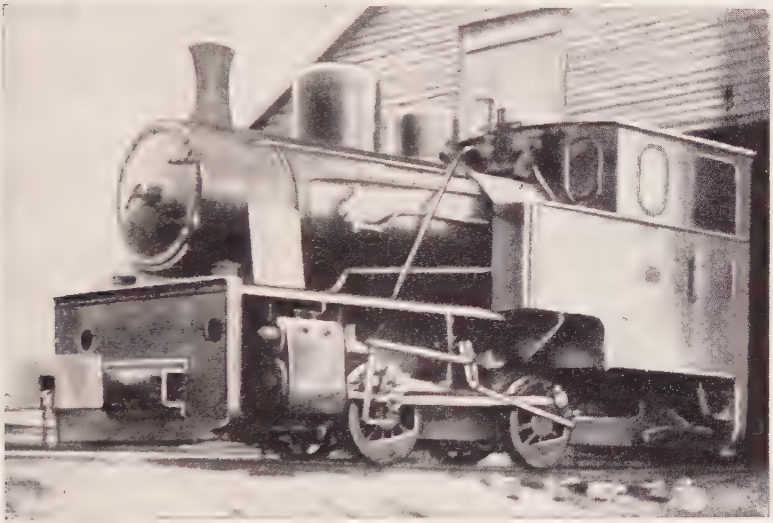
Work on the first line in Finland, Helsinki to Hämeenlinna, commenced in 1858 and the line was opened in 1862 thus linking the Häme district with the Gulf of Finland; this line was later extended to Turku and Tampere. Then by 1870 the Lahti–Viipuri–St. Petersburg line was completed and the success of these railways prompted extensions during the next three decades by both State and private interests. Unlike west European countries there are plans in Finland for extensive additions to the railway mileage, in part to adjust the system to the new frontier and in part to open up fresh mining and industrial centres.

Norway

Norway offered many obstacles to railway construction but Robert Stephenson acted as Chief Engineer for a line, built by British capital, from the capital to Eidsvoll, terminus of the Mjøsa navigation and this line of 42½ miles (68 km.) was highly profitable and encouraged further construction. Unfortunately a narrow-gauge (3 ft. 6 in., 1,067 mm.) was introduced, even on the State lines, but much of this has been converted to standard gauge. The railway pattern consists essentially of lines radiating out from Oslo—to Stavanger, to Bergen, to Trondheim and Lønsdal, towards Stockholm and towards Göteborg. Superimposed on this radial pattern, which has only been provided at heavy capital cost, are spur lines which extend either into the valleys, such as the lines to Rødberg, to Byglandsfjord and to Storlien, or to ports, such as Arendal and Åndalsnes, which are off the main routes. The railways are not yet all linked together and there are isolated lines which run inland from various ports and are usually associated with mineral exploitation.

The solution of the problem of connecting the capital and the chief commercial city was long debated. Before the railhead could advance from Voss the best route had to be determined and the choice lay between (i) from Voss to Lærdal and then either by

Steinberg and Hallingdal or by Filefjeld and Valdres; (ii) from Voss by Eidfjord and south of the Hardanger glacier into Hallingdal or Numedal or over Hardangervidda into Telemark, or (iii) from Voss by the route actually adopted along Raundal and Hallingdal. It was an epic of railway construction and the section across the fjell took from 1894 until 1907 to build, largely because of the problem of cutting the tunnel of Gravehals, 17,427 ft. (5,309 m.) long through granite. Not only was the relief difficult but the low temperatures and strong winds made the work arduous—anemometers recording to about 90 m.p.h. (40 m. per sec.) were put out of action by gusts—



A.C.O.] [*August, 1955*

FIG. 173.—THE MOST NORTHERLY LOCOMOTIVE IN THE WORLD.
This narrow-gauge locomotive serves the coal mine at Ny Ålesund, Spitsbergen.

while drifting snow choked the tunnel mouths so that the rock debris could not be removed in winter. Italian tunnellers were employed first, but were unable to withstand the climate and had to be replaced by Norwegians. On this line between Bergen and Oslo there are 184 tunnels with a total length of about 24 miles (38 km.). The summit on this line, 4,267 ft. (1,300 m.), compares with 4,494 ft. (1,370 m.) on the Brenner route and 4,244 ft. (1,294 m.) on the Mont Cenis route which are over 15° of latitude further south and enjoy a milder climatic régime. Some of the lines are patronised by tourists because of their scenic attractions, and among these is the line from Myrdal to Flåm which descends 2,837 ft. (865 m.) by great spirals in

a route of 16 miles (24 km.). The northward projection of the railway has been expensive (though perhaps it did not at first seem so when it was described as a krone a millimetre), and the extension from Grong to Lønsdal 717 miles (1,156 km.) from Oslo, was pressed forward during the Occupation; the first train crossed the Arctic Circle in August, 1947.

Sweden

The great mileage of railway compared with area in Sweden is due to the influence of central and southern Sweden and if the vast barren Norrland be excluded the figure is considerably higher. The length of railway per 1,000 inhabitants is the highest in Europe, and this is due to the large mileage in Norrland which has only 11 persons per sq. mile (7 per sq. km.) as against 105·8 (40·7) in Götaland and 88 (33·8) in Svealand.

The railways of Sweden fall into a well marked pattern which can be analysed as follows:

A. Norrland Lines, north of railway from Gävle to Mora:
   a. Longitudinal lines parallel to the coast.
      i. Coastal line, Gavle–Härnösand.
      ii. Central line, Ockelbo–Bräcke–Boden–Karungi.
      iii. Inland line, Orsa–Östersund–Gällivare.
   b. Lines of penetration from the coast.
      i. Lines from coast to central railway.
      ii. Lines from central railway to inland railway.
      iii. Lines from inland railway towards the Norwegian frontier.

B. Central and South Sweden:
   a. Lines between principal towns; these often function as penetration lines from the coast.
   b. Lines parallel to the coast.
   c. Lines connecting Sweden with Norway.

The railway pattern developed late. In the first half of last century rails were laid in the Bergslagen mining district for horse-drawn wagons. The first modern railway to be opened in Sweden was the British owned 11 mile (14 km.) standard gauge line from Arboga to Örebro in 1856. The Riksdag decided in 1855 to begin building on a large scale. Work was started near Göteborg, and from the opening of the first section in 1856 438 miles (699 km.) were completed in six years; these included the lines from Göteborg to Stockholm and from Malmö to Liatorp (south of Vislanda) on the route to Stockholm. After the trade depression of the late '60s there followed a period of rapid expansion in the '70s, mostly with

the aid of British capital. In 1870 the first railway in Norrland was opened and from this date for fifty years there was vigorous development of the north. The inland railway from Kristinehamn in Värmland to Gällivare in Lapland was opened in sections over twenty-six years, the final link being completed in 1937. The latest railway to be completed in Sweden is from Uricehamn to Jönköping. The idea for this 96 miles (60 km.) railway, which took eleven years to build, originated in 1845 but only came to fruition as a relief measure for unemployment, and it was only actively built in years of bad trade. Fear of Tzarist Russia influenced the building of this line away from the coast. For similar strategic considerations the railway from

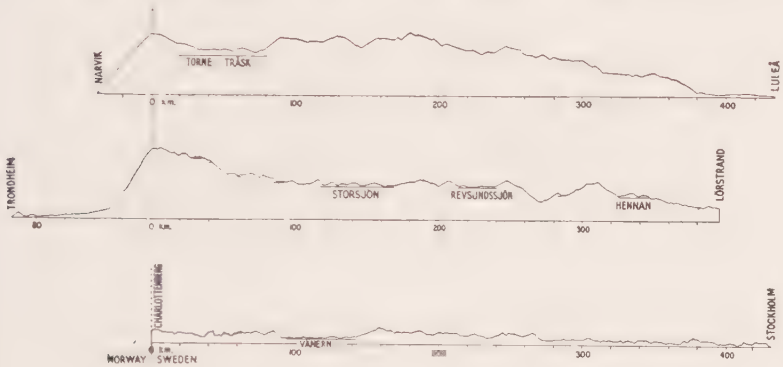


FIG. 174.—GRADIENT PROFILES OF THREE NORWAY–SWEDEN ROUTES.

The severity of the two northern routes is seen by the sharpness of the western ascent to the water-parting. The vertical scale is · 80 the horizontal: the ticks below each base line indicate 20 km. (8½ miles) from the frontier while the horizontal lines below the profiles indicate lakes which are paralleled by the railways.

Based on various technical publications.

Haparanda to Övertorneå, parallel to the Finnish frontier, was constructed in 1914–18. While most of the railways have been built to foster the economic development of the country, the plans of all projected lines have to be approved by the General Staff. Most of the lines are now owned by the State and about three-quarters of the mileage is of standard gauge; the narrow-gauge track is mainly found in the agricultural south. Track construction is in general substantial, although the Inland Railway (Gällivare–Orsa) was built for lighter loading because traffic was expected to be limited but the mineral-carrying lines joining Göteborg and Gävle *via* Falun are equivalent to British mainline standard. Tunnel construction has not been extensively required except in the Stockholm district and on the line from Uddevalla to Skee where subsidence of the land has

left little or no coastal plain for aligning a track. Bridging is unavoidable, especially on the north–south lines of Norrland: for example in the 311 miles (498 km.) from Boden to Långsele there are twelve large bridges, and bridges and viaducts make up 0·5 per cent of the length of the line:

	ft.	(m.)
Over the river Lule	531	162
Pite	246	75
Byske	200	61
Petike	210	64
Skellefte	397	121
Vindel	594	181
Ume	587	179
Öre	554	169
Logde	256	78
Gide	295	90
Fax	394	120
Ångerman	817	249

Many of the Swedish railways are built on unconsolidated material, such as eskers, and although these provide easy gradients, they are liable to slip after heavy rains or during a sudden thaw, so along lines subject to slip automatic warning devices have been installed. Crossing of peat bogs has required special technique in railway construction.

Denmark

From the table on p. 476 it can be seen that Denmark had a remarkable length of line for the area covered; but the recent closure of a considerable mileage has somewhat reduced this. In the virtual absence of mineral resources passenger traffic is the main source of revenue. Railway construction was relatively easy, except for the need to construct long bridges or else use rail ferries; but even so, because of the need to economise in construction costs the lines have steeper gradients than might be expected from the general relief. The first railway to be opened was that from København to Roskilde in 1847 (20 miles, 32 km.) but construction did not become active until the late 1860s. With Free Trade in grain the British market assumed new significance in the second half of last century and so cross-lines to the exporting port of Struer, on Limfjord, were constructed. About 1900 a great mileage was added but this was primarily to fill in gaps between the State Railway trunk lines. In the inter-war period rail communication in and around the capital was improved, but there was little fresh construction of significance, apart from new bridges, for by then the country was well covered and railway traffic was declining in the face of road competition. Of the bridges the most important were the Little Belt Bridge, 2,953 ft. (900 m.), opened in 1935, the Storstrøm Bridge in

1937 (10,499 ft., 3,200 m.) and the Oddesund Bridge across the Limfjord in 1938. This provision of bridges in place of train ferries has allowed considerable accelerations to be made: the opening of the Storstrøm Bridge reduced the time of rail journeys by fifty minutes. One of the interesting features of railway operation in Denmark is the working of the train ferries which connect to Germany and Sweden as well as between the islands. The two islands of Mors and Ærø, which are without railways, can receive road vehicles by ferry to avoid rehandling costs. A bridge or tunnel has been proposed across the Sound but the idea has not received support from the State authorities.

Iceland

A railway was proposed in the 1920s to run from Reykjavík to Þórsá but the plans did not materialise and it is difficult to see the justification for it when the same amount of capital could lay out a greater mileage of the roads which are so urgently required.

Railway operation

The pattern of the railway network can be seen from Figure 171. In Norway the focal point is Oslo while in Sweden the north–south lines act as a spine from which ribs extend (see Figure 54). In Denmark the pattern is again radial from København with important north–south routes in Jylland: the lines parallel with a coast are located about 6 miles (10 km.) in from the shore in order to tap as large an area as possible. Of the urban areas Stockholm has the most elaborate pattern and details of this are summarised in Figure 65. Most of the rail routes of Scandinavia are associated with valleys but one conspicuous exception is the main line of the south of Finland which follows the great Salpausselkä ridge while the cross-lines of the lake plateau are aligned between the lakes. The coastal towns along the Gulf of Finland have to be reached by branches from the Lahti–Viipuri ridge route and this makes for slow and tedious rail travel.

Fuel supply is a problem in railway operation. In Denmark there has been a major change to diesel power whereas Norway and Sweden have the opportunity of using hydro-electricity and Finland once used wood fuel to reduce coal imports. Electrification has made great strides in Sweden since the experimental electrification of the Lapland railway from Kiruna to the Norwegian frontier and the results have justified the conversion, although the capital costs are great. Probably this electrification policy has saved an annual import of 0·4 million tons of coal, which proved an asset during the recent war. Electrification has accelerated many runs, for example

by 17·6 per cent on the Malmö–Göteborg route. To-day Sweden has the longest stretch of electrified route in the world in the 1,350 miles (2,160 km.) from Trälleborg in the south to Riksgränsen in the north. Electrified track in Denmark is provided only for the København suburban traffic, whilst the long-distance express traffic is catered for by the "Lyntog" diesel-electric trains. The Finnish Railway Administration has not turned to electrification, probably because of the limited traffic and the availability of birch hardwood for fuel. The stacks of split logs, with their ventilation spaces, were a feature of the landscape while the use of wood necessitates anti-spark chimneys on the locomotives and long halts for refuelling. During the two World Wars Sweden built up stocks of wood fuel but much of this was allowed to rot away. The graph of fuel consumed in Sweden by the State railways shows the rapid fall in coal consumption following electrification, although the mileage rose from 2,612 to 5,016 miles (4,199–8,026 km.) in the period. The usual sources of coal are Britain and Germany although, as in 1932, some supplies have been drawn from Spitsbergen. Swedish coal does not meet much of the slight demand for locomotive coal.

The snow clearance problem is greatest in Norway and it is tackled by the use of snowploughs: the rotary plough has to be used on the Bergen line where the snowfall is severe. To avoid snow blockage snowsheds and snowscreens have been provided while the road bed is raised on low embankments to prevent snow drifts from forming over the rails, but static defence measures will not keep the lines clear. The Bergen Railway has ten miles (16 km.) of snowsheds and 20 miles (32 km.) of route with screens.[1] Actual handling of goods may be slowed down by intense cold as on the Lapland ore railway when the ore sometimes freezes in the hopper wagons so that unloading is difficult. On the electrified lines frost can break down insulation in the locomotives. Icicles form in winter in the tunnels; the frequent passage of trains keeps them pruned but if abnormally large loads pass through these may be damaged by the icicles. Windows of passenger coaches have two thicknesses of glass with an air space between to insulate the interior from the intense winter cold.

The Baltic is physically suited to the operation of train ferries as it is a practically tideless sea with a rise and fall never exceeding 2 ft. (0·6 m.). As a result, the lifting devices for raising vehicles on board are not so elaborate as those required at Dover, for example, where the tidal range is $18\frac{1}{4}$ ft. (5·6 m.). In severe winters, such as in

[1] The Finse Hallingskeid section is liable to be covered in thick snowdrifts and snow is not infrequent in June; a deviation including a long tunnel has been proposed.

February and March, 1929 and 1940, ice can stop the ferry services. The Baltic rail ferries are the result of action taken by the government of Denmark, which in 1903 purchased steam packets on the Warnemunde–Gjedser route and replaced them by rail ferries. This

Principal International Train-ferry Routes 1938–9

Route	Distance		Operating	Time of crossing train ferry	Traffic 1938–9	
	km.	Nautical miles			'000 Passengers	'000 tons goods
Hälsingborg to Helsingør (Elsinore)	5	2¾	Danish State Rlys.	22 mins.	974	42
Malmö to Copenhagen	25	13½	Danish and Swedish State Rlys.	1 hour 20 mins.	208	121
Trälleborg to Sassnitz	100	54	German and Swedish State Rlys.	4¾ hours.	152	337
Gjedser to Warnemunde	44	23¾	German and Danish State Rlys.	2 hours 10 mins.	196	251

Railway Statistics: 1937 and 1960

	Denmark		Finland		Norway		Sweden	
	1937	1960	1937	1960	1937	1960	1937	1960
Length: miles	3,145	2,670	3,670	3,240	2,482	2,720	10,467	8,960
km.	5,032	4,300	5,872	5,223	4,171	4,358	16,883	14,458
Passenger-km.: '000 million	1·6	3·4	1·1	2·3	0·7	1·7	3·1	5·2
Ton-km.: '000 million	3·4	1·4	2·6	4·9	0·8	1·5	5·6	10·9
Railway rolling stock owned (1955):								
Locomotives	836	627	781	894	547	552	2,151	?
Coaches	3,610	3,191	1,641	1,617	1,404	1,441	5,216	6,090
Wagons	10,638	15,485	24,756	26,169	12,031	13,222	48,351	72,562

(Based on Transport Tables, *U.N. Statistical Yearbook*, *1958*, and *ibid.*, *1961*, Table 136)

replacement was found profitable as German-Scandinavian traffic was diverted to this route, and so the German and Swedish Governments in 1909 turned the Sassnitz–Trälleborg route into a train ferry service despite its long sea passage. Though intended for passenger traffic the service soon developed an important goods traffic as well.

A.C.O.] [*April, 1953*

FIG. 175.—WAGONS BEING SHUNTED ON TRAIN FERRY AT COPENHAGEN.

Rail traffic

Traffic on the Finnish railways has grown almost continuously during this century: but a contrast is provided with the other Scandinavian countries in that freight normally contributes most to the receipts. Of the freight hauled lumber provides over half the amount and so the railway revenue is very dependent upon the world demand for lumber and its products. Transit traffic from Finland to the other Scandinavian countries is handicapped by the fact that the Finnish rail gauge is the Russian 5 ft. (1,524 mm.) in place of 4 ft. 8½ in. (1,435 mm.): mixed gauge track is laid between Torneå and Haparanda.

The position of Sweden, and its industrial and commercial importance, are responsible for a considerable flow of international traffic, both overland and on the train ferries. The services provided are an asset to Swedish industry.

The paucity of concentrated freight traffic, which stems from the

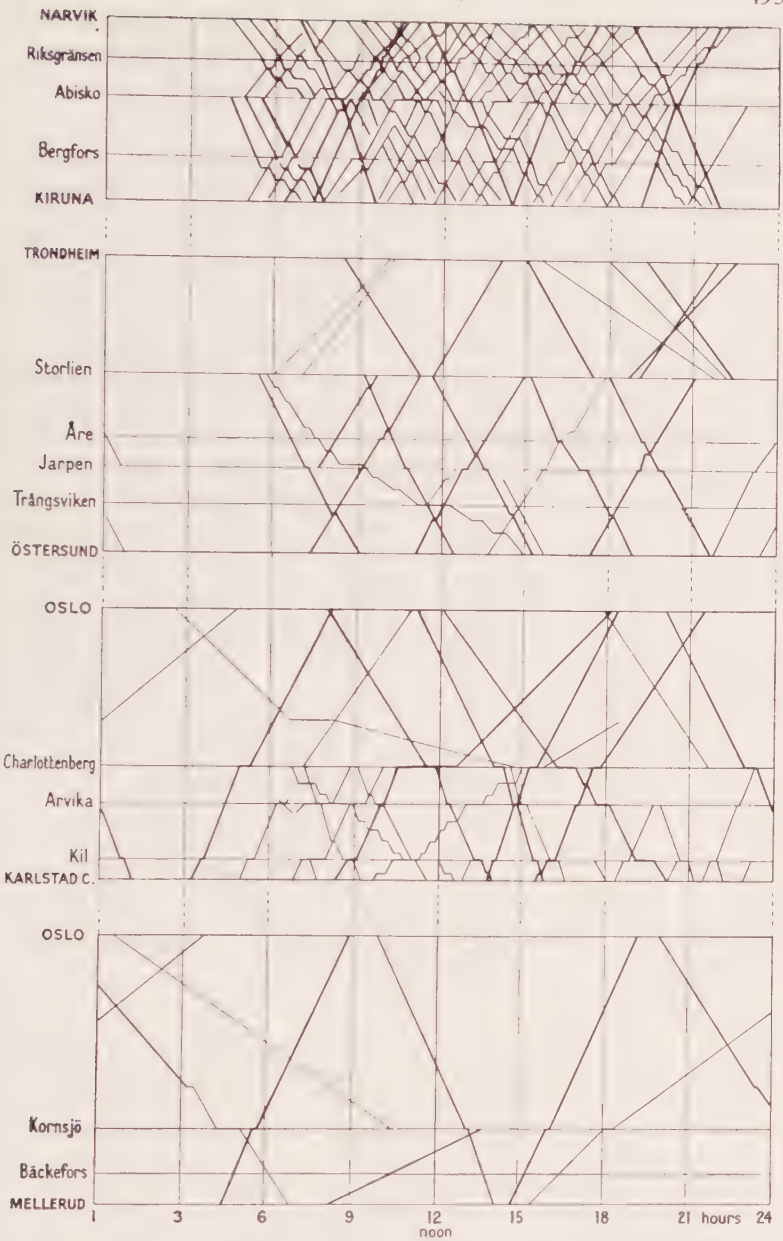


FIG. 176.—TRAINS ON NORWAY–SWEDEN CONNECTING RAILWAYS, 1937–8.

Lines represent the passage of trains, heavier lines passenger trains and lighter lines freight. Time scale from left to right and vertical scales of all four diagrams proportional to rail distances. Note intensity of traffic on Narvik–Kiruna line compared with the more southern routes.

Based on *Sveriges Statsbaner Grafisk Tidtabell*, Nr. 137.

absence of dense industrial or mining areas, has resulted in but a slight development of elaborate marshalling yards. There are of course such key-points—Århus, Fredericia and København in Denmark, and the great nodal point of Hallsberg in Sweden—but their scale is not great.

Special freight rate reductions have been granted in Sweden to stimulate exports. Reductions on the following commodities are

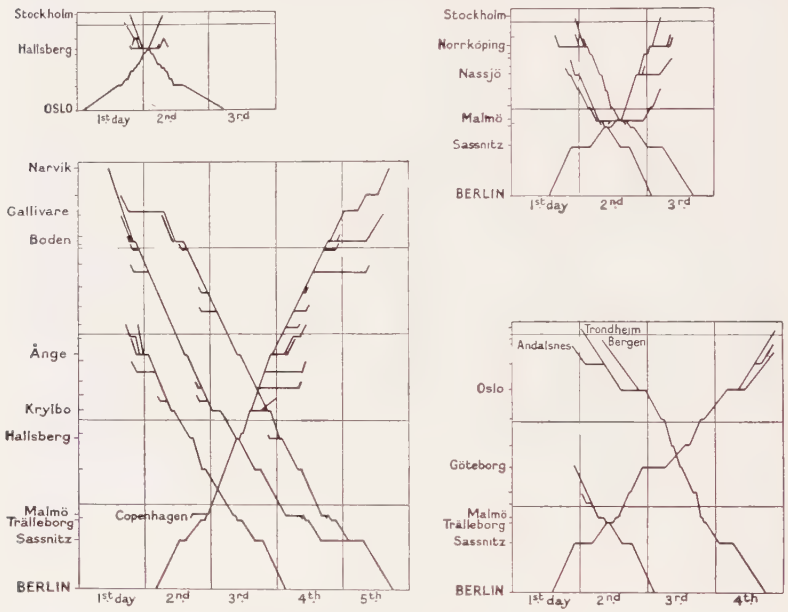


FIG. 177.—GOODS TRAIN SERVICES ACROSS SWEDEN, 1937–8.

These diagrams illustrate the times taken from Narvik, Trondheim and Swedish centres to Berlin. The vertical scales are the same between the diagrams and are proportional to the rail distances. Main connections are indicated to the correct time and distance scales but these branch services are not named.

Based on *Sveriges Statsbaner Godstågstiderna*, 1.5.1937–14.5.1938.

especially noteworthy: sawn goods from a number of stations in northern and central Sweden to Sundsvall, Norrköping, Kristinehamn, Gothenburg, Hälsingborg and Malmö: pulpwood and logs to Kristinehamn; pulp to Söderhamn, Kristinehamn and Göteborg; ore to Stockholm and Norrköping; tar and wood distillation products to Stockholm (Värtan), Trälleborg, Hälsingborg, etc. For goods moving in the opposite direction coal and coke are granted reduced rates from Kristinehamn, Göteborg, Trälleborg, Norrköping and Värtan. The sidings at a number of harbours have been

enlarged to cope with the increased flow of goods traffic and now, as examples of the scale of operations, the sidings at Göteborg and Värtan can each accommodate more than 1,000 wagons. When the Norrland ports are icebound extra goods trains are run to and from the north and these are faster than the normal timings: goods train timings, as examples, are Eskilstuna to Hälsingborg (353 miles, 569 km.) 36 hours, Göteborg to Malmö (185 miles, 299 km.) 10 hours, Stockholm to Göteborg (283 miles, 456 km.) 13 hours.

Total tonnage figures for freight hauled on the railways do not mean much but one striking feature is that in Denmark, despite road competition, the railways were in 1939 hauling two and a half times as much as was moved by coastal shipping; much of this however was haulage between the ports and their immediate hinterlands. For commodities, such as eggs being sent for export from Esbjerg, the area immediately round the port was served by road vehicles and only the long-distance traffic remained faithful to the rail.

INLAND WATERWAYS

Despite the winter freeze, and the subsequent flush of water, considerable efforts have been made to improve the waterways for transport, largely because of the liberal endowment by nature of rivers and lakes: Finland alone has some 60,000 lakes which are connected by rivers or separated only by short portage routes. As industrial activity started in Scandinavia, so improved waterways were provided suitable to take lake steamships.

Canals in Norway which were constructed in the second half of last century are confined to the area of the south. These canals, such as Bandak, Skien and Halden, serve as links between the coast and navigation on the lakes. Lakes were once important but this navigation is now of little more than tourist value, except on Mjøsa and on Tinnsjø; the latter provides the only link with the isolated Rjukan railway. Some of the rivers draining to the Arctic Ocean are navigable during the summer and although their importance was once great provision of roads has decreased the value of these waterways.

Among the Swedish canals the most impressive link is that of the Trollhättan and Göta Canals but only the former is of major importance nowadays and has justified the expense of reconstruction to accommodate vessels drawing 16 ft. (5 m.).

To overcome a difference of level of 249 ft. (76 m.) between Lake Saimaa and the Gulf of Finland the Saimaa canal was constructed 1845–56. Reconstruction work in progress in 1939 was stopped by hostilities, and now half the length is in Soviet territory. Other

canals were also constructed in Finland; there are 36 canals altogether, and until the coming of motor-transport they played a vital part, although passenger traffic now goes by road. Lumber is the largest single source of industrial activity and this has meant that the mills were established alongside the waterways. Logs floated down the rivers are collected into rafts for passing along the lakes, and so save a heavy wastage; to avoid breaking the rafts at canals a new type of lock which will be able to take a whole raft is being introduced at key points, the first installed being at Utra on the Pielisjoki river. The total length of waterway used for floating logs is some 8,700 miles (14,100 km.). A speciality, now practically extinct, was the development of rowboat channels by which tar was conveyed in rowboats which shot the rapids. After a useful life, prolonged by their tourist value, most are now disused.

SEAPORTS

Without an appreciable tidal range along its inhabited shores there has been no need for the provision of wet docks and so the Scandinavian people have been able to provide a profusion of loading places with deep water alongside: in Sweden alone there are some 600 loading points and in Denmark 427. Most difficulty in obtaining sufficient deep water is experienced along the coasts of Denmark, particularly in the west coast of Jylland, while in the north of the Gulf of Bothnia isostatic uplift has led to the shallowing of ancient ports. During the Second World War the existence of German minefields confined shipping to the territorial waters off the south-west of Skåne, and as these were too shallow the Falsterbo Ship Canal was dredged across two shallow bays, and across a narrow spit of land. There are also dredged approaches to some ports, for example Esjberg, but these are exceptional in Scandinavia.

Probably the greatest obstacle to port operation is the liability to winter closure by ice which disrupts or impedes industrial activity in the affected parts of Finland and Sweden. The U.S.S.R., which had no ice-free ports on the Baltic, obtained control of the Porkkala area in order to free herself from this bondage, but the acquiring of the East Baltic States has provided better outlets. Hanko and Turku can usually be kept open by the use of icebreakers while in Sweden the liability to frequent trouble by ice extends as far south as Stockholm. The more saline and warm waters of the North Sea and Atlantic keep the other Scandinavian ports free of ice, except those of Greenland and occasionally those of the north of Iceland which are set in colder waters.

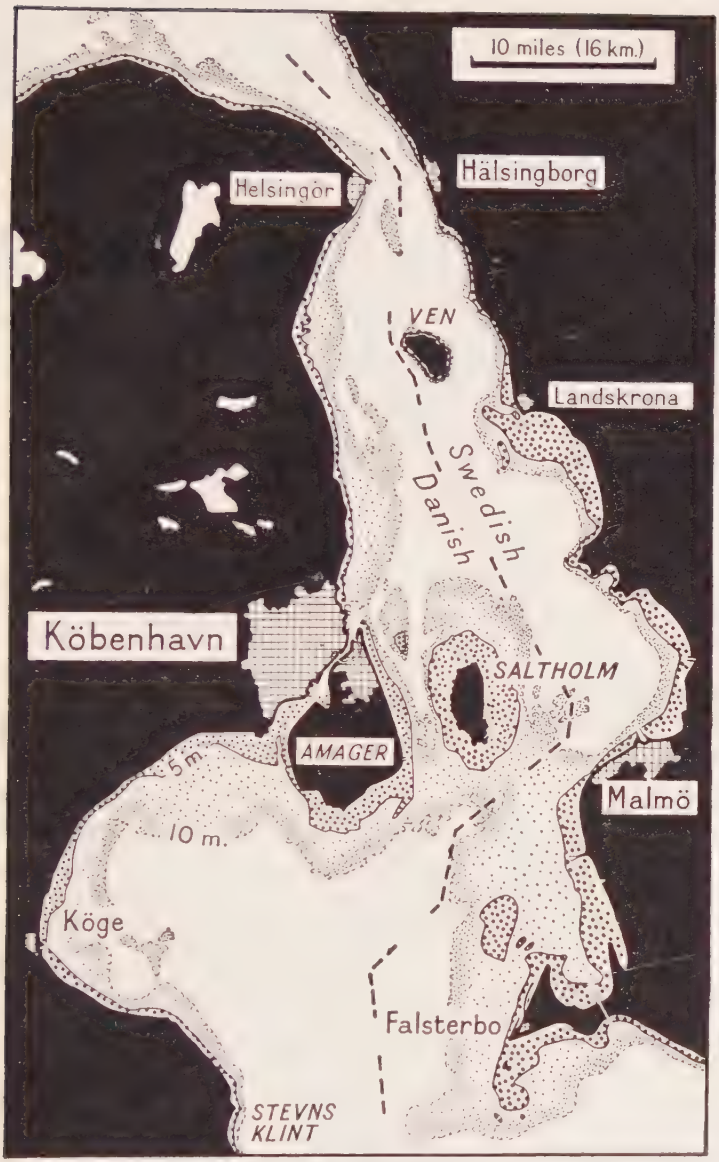


FIG. 178.—THE SOUND.

The narrowness of The Sound, which gave power to control it to the Kings of Denmark, and the shallowness, which hindered Nelson in his attack on Copenhagen in 1801, are clearly demonstrated. Shallow-water areas are stippled. A proposal to dam it, with pumping equipment, was rejected as unfeasible by a Dano-Swedish Commission in 1953.

Many of the ports are of ancient lineage: Turku, for example, goes back as a port to the Viking period. In the region of the Sound the Danish Coast offers better natural sites for seaports than the coast of Skåne, but both countries have here old established ports on account of the ebb and flow of traffic between the Baltic and the

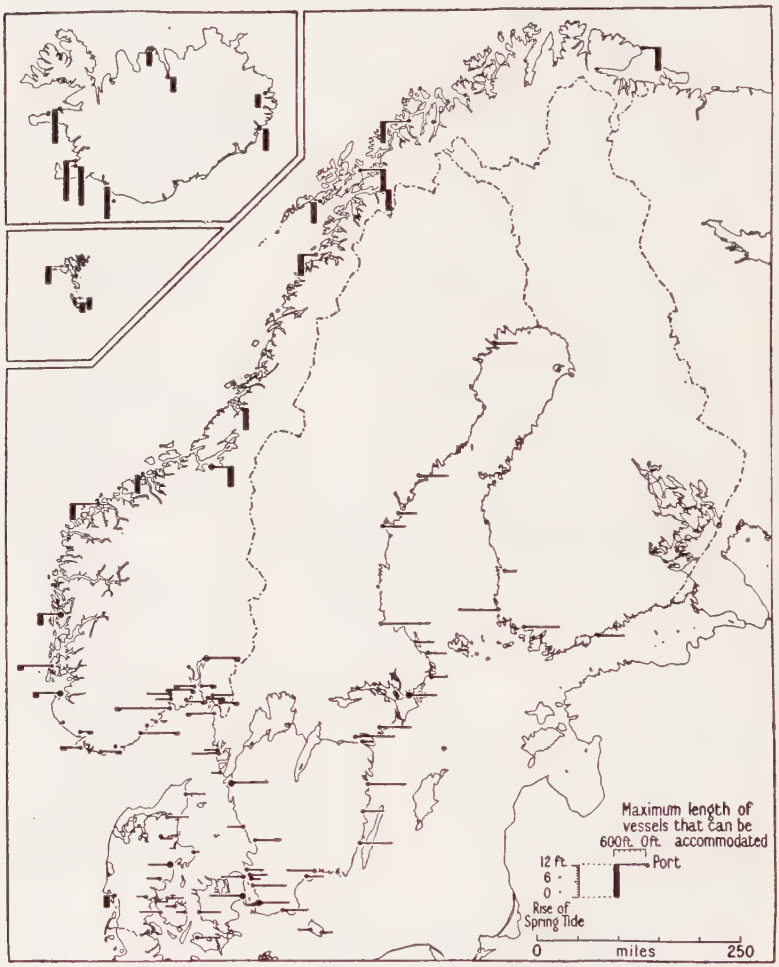


FIG. 179.—PORT FACILITIES OF THE SCANDINAVIAN WORLD.

Tidal range, shown by the vertical columns, is negligible in the south and increases with latitude except in the East Sea where there is no tidal range of any significance. Port facilities, as given by the length of the longest vessel which can be berthed, are greatest in the south and less in the north.

Based on data given in Admiralty Sailing Directions.

North Sea and between Skåne and Sjælland. If the southern sites are cramped, lacking drowned estuaries, at least they are not liable to rapid silting as the small streams, having crossed low terrain in well-graded valleys, do not carry vast quantities of silt.

Sites for seaports are less frequent in Iceland than would be thought by analogy with, say, Norway. The fjords lack the rectangular bends of Vestland and have the appearance of more open inlets, similar to those of Finnmark. Protection is frequently required from the fetch of seas while, with active deposition of debris brought by the large, eroding rivers, it is also on occasion necessary to protect port sites from the landward side. The south-eastern sector of Iceland offers no possibility for seaport construction while the north-western peninsula is so isolated by the incised relief that outlay on port works would serve few people.

Port facilities are indicated in Figure 179 which shows how much Scandinavia is served by her ports, while the following statistics indicate the enormous tonnage of shipping which each year uses the ports of the greater countries:

External Shipping, Vessels entered 1938, 1950, and 1959, million net registered tons

	1938	*1950*		*1959*
	Total	*Total*	*Under national flag*	*Total*
Denmark . .	14·8	15·5	7·8	32·6
Finland . .	8·0	7·1	2·0	7·7
Norway . .	9·7	8·9	4·3	14·5
Sweden . .	41·3	29·1	7·8	35·1
Færoes . .	0·14 (1939)	0·02 (1945)	0·002 (1945)	—
Iceland . .	0·25	0·25 (1943)	0·02 (1943)	—

(Based on *Statistisk Årbog, 1952*, Tables 284 and 286, and *Statistisk Årsbok för Sverige, 1961*, Table 452)

THE MERCHANT MARINE

The flags of the Scandinavian States may be seen in every seaport open to foreign trade throughout the world. Not until the '90s did the replacement of sailing ships by steamships make rapid headway, whilst in this century a distinguishing feature of the Norwegian, Danish and Swedish fleets has become the high proportion of motor vessels. The coasting trade is stimulated by the shelter of the skjærgård of Norway and by the Baltic Sea which, when not closed by ice, is threaded by shipping lanes. The scale of operations is extensive as seen from the table of distances between various important trading ports.

Distances between some East Sea and adjacent ports
(Nautical Miles)

											Oslo
										Göteborg	162
									Hälsingborg	114	249
								København	23	136	271
							Kiel	160	183	228	356
						Jonköping	442	365	377	490	626
					Stockholm	101	499	412	434	540	683
				Gävle	138	263	608	521	543	656	792
			Sundsvall	114	216	334	679	592	614	727	863
		Härnösand	40	127	223	341	686	599	621	734	870
	Örnskoldsvik	57	86	171	260	378	723	636	659	771	907
Skellefteå	159	189	216	293	372	490	835	748	770	883	1,019
Luleå	79	205	235	262	339	418	536	881	794	816	929	1,065

(Based on Örnskoldsvik Port Broadsheet. 1 nautical mile = 1·85 km.)

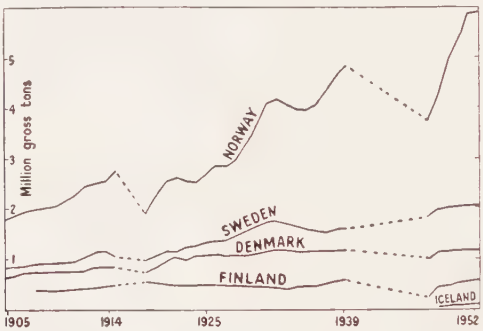


FIG. 180.—MERCHANT FLEETS OF SCANDINAVIA, 1905–52, GROSS TONS.

The recovery from war losses during two world wars is an indication of the vigour of the shipping companies concerned.

Based on *Lloyd's Register, 1939–40* and *U.N. Statistical Yearbook* 1953.

Mercantile Marine Fleets, June, 1939, 1951, and 1961

	1939 Total vessels over 100 tons gross	*1961 Total gross tonnage*	*Gross tonnage per '000 inhabitants*		
	'000 tons	*'000 tons*	*1939*	*1951*	*1961*
Norway .	4,835	12,025	1,663	1,782	3,353
Sweden .	1,582	3,996	252	302	534
Denmark .	1,176	2,307	310	314	503
Finland .	626	854	172	137	192
Iceland .	31	109	265	587	619
U.K. . .	17,891	21,465	377	369	409

(Based on *Statistisk Årsbok för Sverige, 1941*, p. 393, *ibid., 1962*, Table 475, and *Statistisk Årbog, 1952*)

In 1651 the Navigation Act imposed by Cromwell on British trade affected Norwegian shippers and it was not until this was repealed in 1849, to be followed by a similar freedom granted by other countries on the right to carry goods to their shores, that the Scandinavian carrying trade really developed. The largest merchant fleet is that of Norway, and its earnings are sufficient to pay for one-third of her imports. The Norwegian fleet is modern, with over four-fifths of the vessels motor-driven. Three-fifths of the fleet are oil-tankers which represents one-sixth of the world's tanker vessels: the size of these tanker units has been increased and now there are vessels of over 30,000 tons d.w. About half the 1939 merchant fleet was lost in the recent war, but the tonnage has been made good by building, not only in Norwegian yards but also, and to a greater extent, abroad,

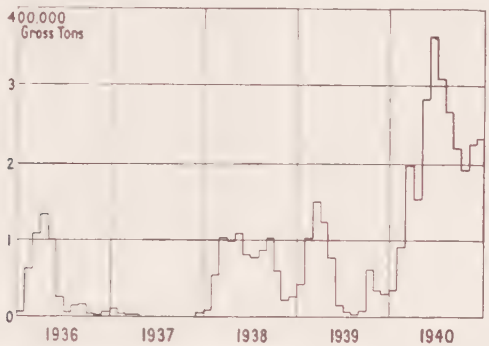


FIG. 181.—SWEDISH TONNAGE WITHOUT EMPLOYMENT, 1936–40.

This graph is of the monthly tonnages and shows how the impact of war rendered a large proportion of the Swedish tonnage redundant.

Based on *Stats. Årsbok*, 1940, Table 114.

where foreign loans could be obtained. Oslo has the greatest registered tonnage of any Scandinavian port: 2·304 million tons (5,183 in 1961) gross compared with København 0·868, Stockholm 0·737, Göteborg 0·734 and Bergen 0·683 (1,498 in 1961) on 1st January, 1950. The domination of Oslo in Norwegian registrations, and the increase of size of vessels, are seen from the table on p. 502.

One specialism in the Norwegian service is the traffic between Europe and the ports of the Great Lakes, a route which has been sailed since 1862. Before 1959 vessels were small, under 2,500 tons d.w., and the number of voyages is restricted as the navigation is closed for five months. While the cargo liner trade has greatly expanded, many companies still maintain the tramp trade which was the original activity from which the liner trade sprang.

The Swedish fleet, which before the war was tenth by gross

tonnage among the merchant fleets of the world, engages widely in international trade and the country gains considerable revenue from the services rendered by her ships. Although a non-belligerent, Sweden lost 17·9 per cent of her fleet during the First World War, compared with a British loss of 37·6 per cent and a Norwegian loss of

Location and changes in Norwegian Merchant Marine, 1920 and 1950 (thousand tons, gross registered tonnage)

District	*1920 Gross registered tons*	*Average size of ships*	*1950 Gross registered tons*	*Average size of ships*
Oslo	549	1·7	2,469	4·9
Drammen	81	1·8	70	3·3
Vestfold	305	2·0	653	3·4
Skiensfjorden	61	1·1	35	3·0
Aust-Agder	64	1·2	281	5·2
Kristiansand S.	125	1·5	214	5·2
Farsund	11	1·4	102	4·3
Stavanger	64	1·2	228	3·5
Haugesund	223	1·7	317	3·3
Bergen	366	1·8	633	3·4
Trondheim	77	1·1	42	1·1
North Norway	15	0·4	66	0·4
TOTAL	1,941	1·6	5,072	3·9

(Based on *Industries of Norway*, p. 307)

49·6 per cent, while in the first three years of the Second World War nearly one quarter of her tonnage was sunk. During the inter-war period the number of direct Swedish services to foreign countries greatly increased and all continents were included in the regular sailing routes. One company operated an ore-carrying service between Cruz Grande on the coast of Chile and Sparrows Point in Maryland, U.S.A., with specially built iron-ore carriers which have been on time-charter since fitting out. These vessels have abnormally low (21 per cent) relation of net to gross tonnage owing to the specific gravity of the cargo which the vessels were built to carry exclusively. As an example of the Scandinavian oceanic services the table on p. 504 lists the major Swedish services in 1938.

These services were operated by seven companies with eighty-four ships and although a number of the vessels were small the aggregate revenue was a considerable asset.

Coastwise shipping extends along 4,738 nautical miles (8,765 km.) of the Swedish coast and there is keen competition between shipping, rail and road transport concerns, particularly for traffic which must

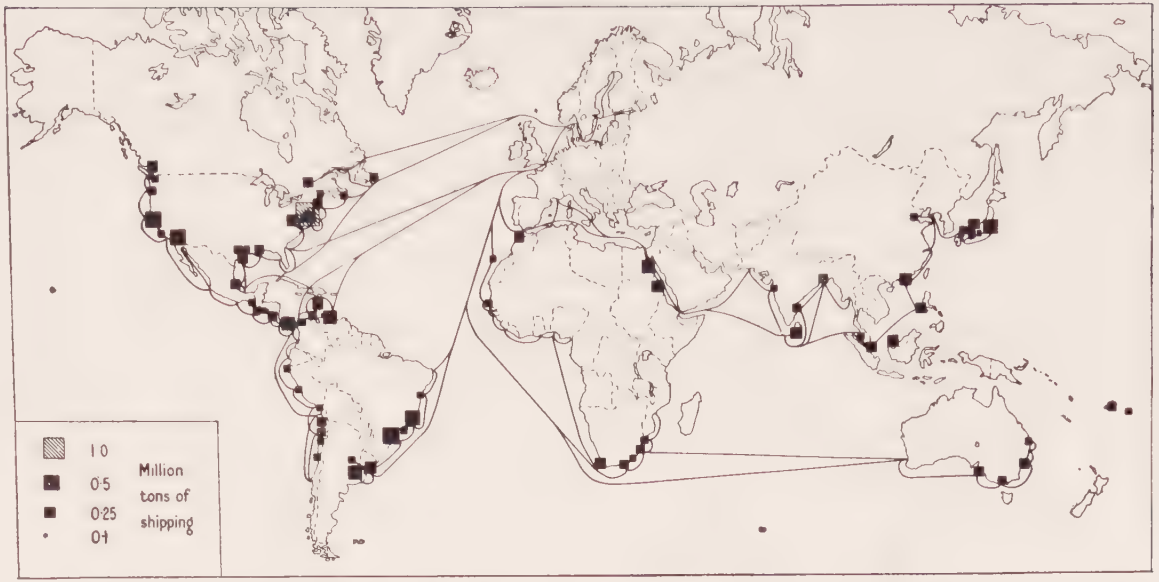


FIG. 182.—SWEDISH OCEAN SHIPPING, 1938.

The ports where Swedish ships called have a symbol proportional to the shipping tonnage. Routes regularly served by Swedish companies are indicated by the continuous lines.

Based on *Sjöfart*, 1938.

Oceanic Services in 1958 by Swedish Companies

Between Sweden and:	*No. of arrivals at destination country*	
AFRICA	1,113	
Morocco		208
South Africa		104
ASIA	1,571	
Iran and Kuwait		298
India		76
Japan		76
AMERICAS	3,185	
Canada		326
U.S.A.		1,068
West Indies		449
Venezuela		291
Colombia		111
AUSTRALIA	150	

be moved parallel to the coast, and this competition was the subject of a parliamentary enquiry. Three-masted schooners, fitted with an auxiliary engine, are much used for carrying firewood and building materials.

The Danish mercantile fleet is also distinguished by the high proportion of motor vessels and although the fleet is fourteenth among the nations by tonnage it is seventh measured against population. As with the Swedish fleet there is a predominance of smaller vessels because of the intense activity in trading coastwise and in the narrow seas. During the Second World War the Danes lost two-fifths of their tonnage but by a vigorous new building programme the fleet by the end of 1950 was one-third greater than the pre-war tonnage. The most famous ship which has been in the Danish merchant navy is the *Selandia* which was built in 1912 at the yards of Burmeister and Wain in København: she was the first ocean-going motor vessel in the world and demonstrated the economy of running on fuel-oil.

After losing fifty per cent of her fleet during the war Finland had by 1952 replaced most of the tonnage lost. Her mercantile marine is insufficient to carry her exports, many of which are bulky. The port with the greatest registration tonnage is Helsinki and the second is Mariehamn. Gustaf Erikson of Mariehamn collected a fine fleet of windjammers but this was irreparably crippled, from losses by war and by the impossibility of economic competition after the abolition of the statutory period of sail-training for Finnish merchant officers, and the fleet was rebuilt with cargo steamers after his death.

Settled from the sea, Iceland long remained entirely dependent upon foreign bottoms and for a long period trade was restricted to Danish vessels. Since the early years of the First World War local companies have participated in the carrying trade with Europe and from 1930 a State service has maintained the coastal routes. The

Icelandic fleet is not large in size or number of vessels, except in relation to the population, but, irregular as the services provided are, they have enhanced the opportunity of contact with the outer world. During the Second World War two of the largest Icelandic vessels

A.C.O.] [*July, 1953*

FIG. 183.—M.V. *Tjaldur*.

This is the largest of the Færoese passenger vessels and trades with Denmark making calls at southern Norway and the Shetland Islands in the summer season in order to increase the tourist traffic. On the side of Trangisvaag can be seen the dark, *hamrar* cliffs of the nearly horizontal lava layers. These hamrar are separated by grassy scree slopes.

were torpedoed but the fleet has since been renewed. The Færoese have also attempted to develop their own fleet but the limited traffic could only allow a few vessels to ply successfully and the loss of one in 1952 disrupted the whole service.[1]

AIR SERVICES

Difficulty of surface conditions has stimulated the supply of air services but these same physical conditions also entail the virtual absence of naturally flat land suitable for airports. In Norway and in Iceland weather conditions too can be a handicap while in all the

[1] The burden of replacement on a small community of 30,000 can be assessed by the cost of the vessel, the M.V. *Tjaldur*, which was £600,000. Local pride can be seen in the name, for the *Tjaldur*, the oyster-catcher, is the national bird of the Færoese.

northern countries there is the problem of the soft snow which covers the runways in winter. Furthermore, apart from Sweden, the Scandinavian countries are relatively poor and the services, except in special cases, have but limited possibilities of passenger traffic.

The most important of the Norwegian routes is Bergen–Oslo–Tromsö but there are several large airports which were constructed during the war. Sola, near Stavanger, is an example, but the Norwegians have also developed Fornebu, near Oslo, from which 282½ million cu. ft. (8 million cu. m.) of rock were removed in order to flatten an area for runways. During the Occupation the works were considerably extended. The journey by air between Oslo and Stavanger takes 80 minutes compared with a pre-war rail journey of 12 hours.

In Denmark, where distances are small, local air services saved little time except possibly from København to Bornholm and to Jylland, but international routes to Sweden, Germany and the Netherlands were developed by a Danish company with a monopoly concession.

Air services from Finland started to Estonia in 1923, and in the following year to Stockholm. At first reliance was placed on seaplanes but in the middle 1930s the first airfields in Finland were constructed, at Helsinki and Turku, and the use of the less profitable seaplane was abandoned. Following the Second World War many military airfields were adopted for civilian uses and now most large towns have air services and there are links with other countries and with the Americas.

The use of civil aircraft has greatly increased since pre-war years and by 1959 had attained the following vast proportions (statistics in millions), with the S.A.S. routes allocated according to the nationality of the portion of the service provided.

Scandinavian air Services

	Scandinavian Air Services (1959)				
	Denmark	*Finland*	*Iceland*	*Norway*	*Sweden*
Miles } flown .	10·0	6·8	4·2	12·3	22·9
Km. } flown .	16·1	11·0	6·7	19·4	30·7
Passenger { miles .	323·0	115·3	144·9	363·6	546·0
Passenger { km. .	520·4	186·1	233·8	591·8	881·1
Cargo–ton { miles .	6·2	1·2	3·3	6·3	10·9
Cargo–ton { km. .	9·9	2·0	5·3	10·1	17·6
Mail–ton { miles .	1·8	1·1	0·19	2·2	3·4
Mail–ton { km. .	2·9	1·7	0·3	3·6	4·9

(Based on *U.N. Statistical Yearbook, 1961*, Table 141)

Because of their location the western islands of the Scandinavian World provide stepping stones for crossing between America and Europe: a pioneer flight along this route was made in 1924. While weather difficulties are greater than those encountered further south, a route *via* Iceland and Greenland from London or København to Vancouver or Tokyo approaches fairly closely to a great circle. To exploit the overseas routes the Scandinavian Airways System was founded in 1946 by Norwegian, Danish and Swedish interests and experimental flights were made 1952–4 along the so-called Polar Route between the Old and New Worlds. The Greenland route

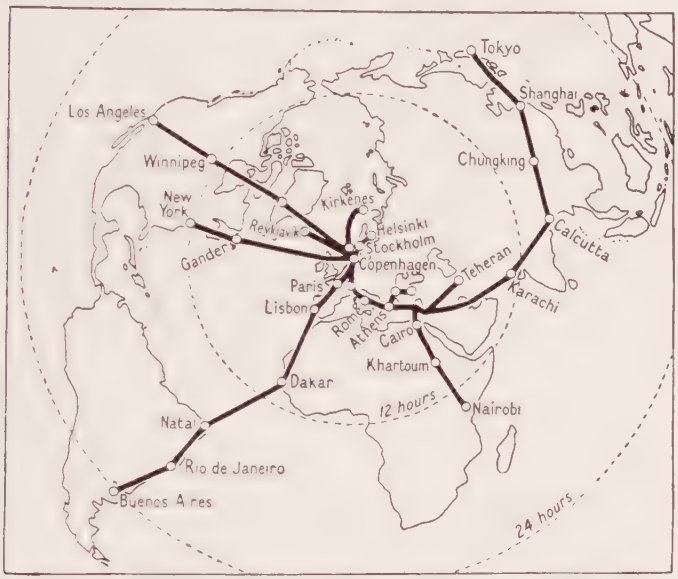


FIG. 184.—ROUTES SERVED BY SCANDINAVIAN AIR SERVICES.

The time from Copenhagen is approximately indicated. The so-called Polar Route goes barely north of the Arctic Circle but since the spring of 1957 there has been a genuine "polar" route between Scandinavia and Tokyo.

from København to Los Angeles, stopping only at Söndre Strömfjord and Winnipeg, was inaugurated in November, 1954. The journey is about 1,000 miles (1,600 km.) less than that by Gander and New York and takes 27 hours westward bound and, because of strong westerly winds, only 24 hours eastbound. To serve passengers and staff a large hotel has been provided at the refuelling point of Søndre Strømfjord. Canadian Pacific Airlines plan a similar route between Vancouver and Amsterdam. The S.A.S. has rapidly extended its routes and Figure 184 indicates the principal world services.

CHAPTER 22

POPULATION

Like all other European nationalities the Scandinavians are mixed peoples. Regional variations occur, for racial peculiarities have been maintained by the isolation of individual districts, and these are particularly well seen in the valley settlements of western Norway or in the Baltic islands. Even in a terrain as uniform as that of Finland two racial sub-groups have been distinguished—the East Baltic (shorter, thick-set, with heavy jaw, broad nose and light colouring) and the Nordic (taller, more slightly-built, with narrow nose and light colouring)—and, because of intermarriage, these two elements occur in both the Finnish- and Swedish-speaking peoples. There are also traces of the Lapp, or Samian, peoples with their short build, broad skull, narrow eye slit and dark colouring, and as would be expected, this element is strongest in the north.

Finns had migrated from Finland into the forest lands of the Glomma area by 1700, and are still found on both the Swedish and Norwegian sides of the frontier. Between 1700 and 1875 large numbers of Finns migrated westward into the northern provinces of Norway, where they are known as Kvæns. There are also Finnish colonies in the Norrland region of Sweden, for no real frontier exists between these two nations: there are about 30,000 Finnish speakers in Sweden, mostly in the valleys of the Torne and Muonio rivers, although a small district in Värmland retains traces of the Finnish language from the immigration prior to 1700. The eastward movement of Swedish people is still distinguishable in the Finnish Bothnian provinces, where in 1880 Swedish was the mother-tongue of 14·3 per cent of the peoples and in 1960 of 7·4 per cent. The main result of this is that the country is divided into monoglot and bilingual areas.

One element in the population which has attracted great attention on account of its different origin and culture is that of the Lapps, The people are brachycephalic, and of dark colouring with deep-set, inclined eyes. They are short, the men being about 5 ft. (151 cm.) tall. These people increased in the Tromsø and Nordland provinces of Norway from 13,000 in 1845 to 21,000 in 1891, but there has been considerable intermarriage particularly with the Kvæns. The Lapp-speaking population of Sweden is now about 10,000 while in Finland it has risen from 961 in 1880 to 2,347 in 1950. The total Lapp population is about 21,000. Their language is Finno-Ugrian but

usually they have also adopted the language of the country and there is a considerable degree of inter-mixture.

Iceland has a population derived from Scandinavian and Celtic sources and although the former predominates both elements can be distinguished by the physical characteristics.

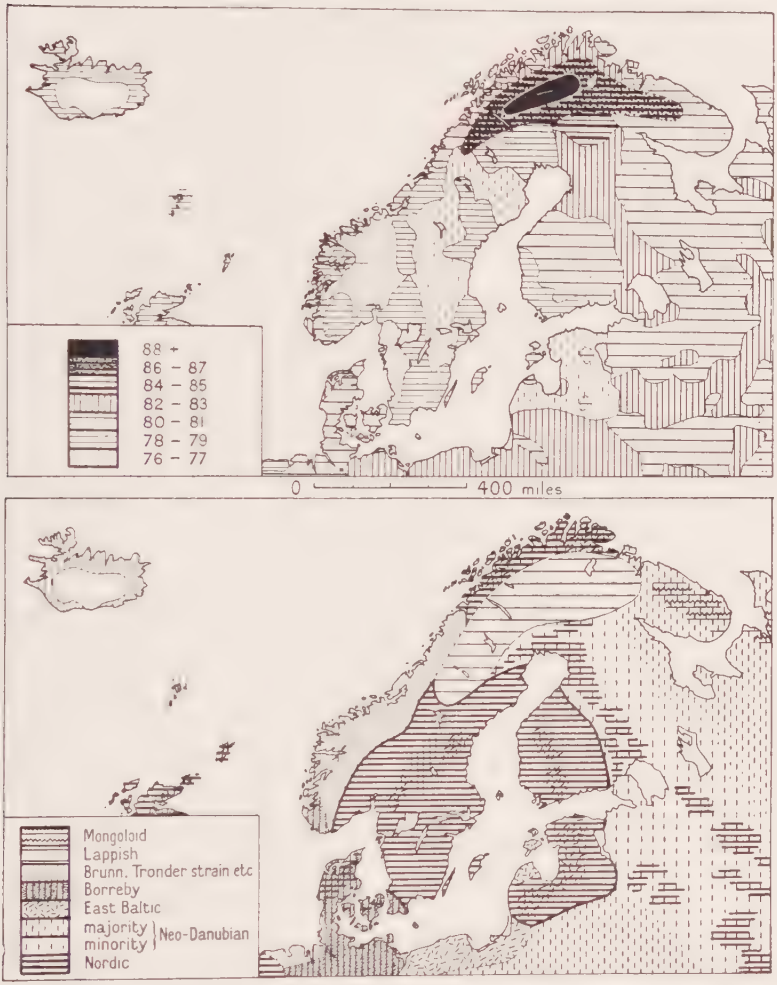


FIG. 185.—RACIAL GROUPS OF NORTHERN EUROPE.

The upper map shows the differences of the cephalic index in northern Europe and the lower the "racial" distribution.

Based, by permission of Macmillan & Co. (N.Y.), on C. E. Coon, *Races of Europe*, New York 1939.

Simplified Summary of Physical Characteristics of People

People	*Mean male height*		*Cephalic index*	*Dominant Eye colour*	*Dominant Hair colour*	*Notes*
	in.	*cm.*				
FINNISH	65–67¾	165–172	79.3–83.3	Blue and grey	Brown and ash-blond	Regional variations due to mixture of groups, Kvæns of north, Tavastians of south and Scandinavian Nordics.
LAPP	59½	151				
Reindeer Lapps			87	Dark	Dark	
Eastern Lapps			80–83	Light	Brown and blond	
NORWEGIAN						
Eastern	67¾	172	76	Light	Brown to ash blond	Ethnic unity in area draining to Oslofjord but isolated from other areas: type Halstatt Iron Age Nordic.
Western	69	175	84	Blue	Brown and rufous	Population of Valle area in Setesdal is survival of saga period.
North-central	67¾	172	82	Blue	Gold and brown	Isolated north of Dovre mountains.
Northern						Mixed of Lapps, Kvæns and Norwegians.
SWEDISH	67¼	172	77	Light	Ash-blond and golden	Similar to Eastern Norway: type Hallstatt Iron Age Nordic. Regional variations between north, Jämtland and south, German, Walloons and Scots stock identifiable, after large scale immigration before 1718 A.D., particularly in south. In north Kvæn element identifiable in population.
DANES	66½	169	80.6	Light	Fair	Taller in Jylland and Slesvig than in archipelago. People on Bornholm resemble Swedish people of Gotland.
FÆROESE	66½	169	79.6			
ICELANDIC	68¼	173.6	78.1	Pure blue	Light-brown or ash-blond	Resemble people of north-central Norway but Irish affinities recognised.

(Based on C. S. Coon: *The Races of Europe*, New York, 1939)

In the Færoes it has been claimed that two races could be distinguished: in the northern islands lived a tall, long-skulled and rather dark-haired people while in the southern isles was a short, round-skulled, fair group: however, Soren Hansen showed that these were not two races, and that the population was homogeneous except for natural variations.

Coon in his book, *The Races of Europe*, has shown how in northern Europe, which was the last part to receive permanent settlement, occur traces of the various elements which have successively peopled the continent. Among the present population can be distinguished the features which link them with the prehistoric peoples whose skeletal remains have now been extensively examined. While this is a core area of the Nordic people, it is fringed by, and has enclaves of, other peoples. The physical characteristics of the main groups occupying the Scandinavian World are given in summary form in the table opposite.

Minorities are not a major problem in the Scandinavian World, probably because the resources do not attract foreigners. In the frontier zone of Slesvig the German nationals were a source of trouble when political issues ran high. The Swedish colony in Denmark was not a problem, neither was the Polish element which came in to help with the sugar-beet harvesting. In Iceland there is no trouble with minorities and most of the immigrants are merchants.

There has long been migration between the different parts of Scandinavia, for the narrow seas have not been an obstacle. In the eighteenth century Swedes crossed in the summer to Sjælland to labour on public works and there are many traces of such movements while they have also spread into Estonia and Finland. In the immediate post-war period there were proposals for a free movement of labour between Norway, Sweden and Denmark but this did not materialise until 1954 owing to the pressing demands for labour within each country. Immigration was particularly important for Sweden after the economic depression and after the war: people from the other Scandinavian countries, from the East Baltic States and from Italy are working in the forests and industries because, with the expansion of industry, the man-power shortage has become acute.

Figure 186 shows the growth of population in the Scandinavian World during the past two centuries. The effect of improved medical services and conditions is seen in the late nineteenth and the twentieth century increases which are apparent despite considerable emigration. Among the limitations on population increase in earlier centuries was the effect of war (Charles XII of Sweden, for example, bled his

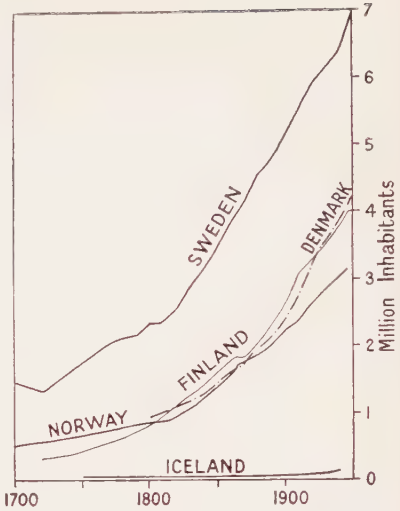


FIG. 186.—POPULATION CHANGES IN SCANDINAVIA, 1700–1950.

Based on various statistical yearbooks.

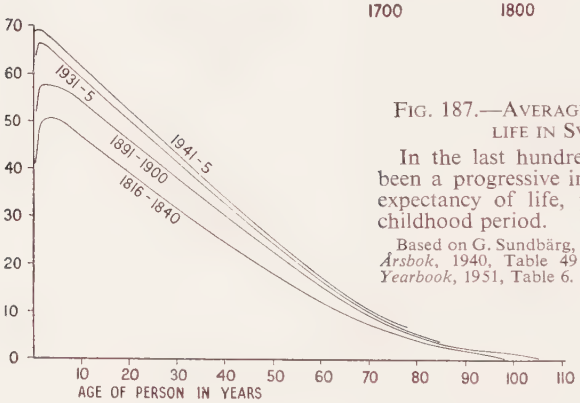


FIG. 187.—AVERAGE EXPECTATION OF LIFE IN SWEDEN.

In the last hundred years there has been a progressive improvement in the expectancy of life, particularly in the childhood period.

Based on G. Sundbärg, *op. cit.*, Table 66; *Stats. Årsbok*, 1940, Table 49 and *U.N. Statistical Yearbook*, 1951, Table 6.

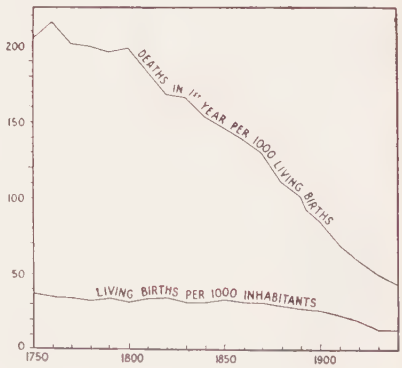


FIG. 188.—BIRTHRATE IN SWEDEN, 1750–1940.

Based on *Stats. Årsbok*, 1940, Tables 46 and 47.

country of man-power in his opposition to the King of Denmark), while famine, plague and cholera all periodically reduced the population. The expectation of life has been greatly increased in the last 150 years as is seen in Fig. 187 and this has meant that the average age has greatly increased. In the Scandinavian countries the excess of births over deaths continued to increase until about the beginning of this century but since then there has been a decline, Sweden having the lowest birthrate. The net reproduction rates of the Scandinavian countries for representative years have been:[1]

Year		*N.R.R.*
1937	Finland	0·964
1948		1·403
1937	Denmark	0·968
1947		1·269
1937	Norway	0·767
1948		1·126
1937	Sweden	0·772
1947		1·133
1940–1	Iceland	1·201

If the net reproduction rate is below 1·000[2] it means that on present trends the population will inevitably decline, because insufficient females are born to keep the population of a country at its present level. This trend had become very apparent in Sweden by 1925 and the Government established a Population Committee to consider the situation; the various reports all agreed that redistribution of income was required among the various classes, by means of free medical care, cheaper houses and greater tax relief for married couples with three or more children and grants similar to those now made in Britain.

DENSITY AND DISTRIBUTION

While these countries occupy an appreciable percentage of the area of Europe their population amounts to a lesser proportion of the European population.

[1] Based on *U.N. Statistical Yearbook*, 1949–50, Table 6.

[2] The Gross Reproduction Rate is average number of female babies to each woman living. Since all girls do not survive and not all who do live have children, this gross figure is corrected to allow for losses at current rates and the new figure is known as the net reproduction rate. The rate of 1·000 means that statistically just sufficient girl babies are born to maintain the population. The findings which can be deduced from this calculation are subject to abrupt changes through war, etc. These changes are illustrated by the comparative years given in the Table.

Population densities

Density of Population 1959			*Percentages of European (excluding U.S.S.R.)*	
Per sq. mile	*Per sq. km.*		*Area*	*Population 1959*
34	13	Finland	6·9	0·95
44	17	Sweden	9·2	1·76
29	11	Norway	6·4	0·84
276	106	Denmark	0·9	0·93
5·2	2	Iceland	2·1	0·04

The principal settled areas in the Scandinavian World can be indicated on a map, but it is not of great significance for, of course, the intensity of rural settlement varies tremendously—from 3·1 persons per sq. mile (1·2 per sq. km.) in Finnmark to over 104 persons per sq. mile (40 per sq. km.) in Fyn (Fünen). In Norway, Iceland and the Færoes, outside the towns and fishing villages, rural settlement is dispersed in scattered farms whereas in Denmark there is a balance between the old villages and the scattering of settlement which occurred after the land reforms in the nineteenth century. Sweden shows considerable regional differences with 7·8 per sq. mile (32 per sq. km.) in Norrbottens län and 344 (132) in Malmöhus län. The most densely settled areas are those with more fertile soils but where forestry and other industry is important the density is also above the average. As the basic pattern of the population distribution is given by agriculture the upper limits of this tend to be also the upper limits of settlement, so that few settlements are found above about 2,000 ft. (610 m.); even this marks a regression down the slopes since the 1880s when over-population was rife. Rural settlement in Finland is dispersed and characteristically located on slight elevations, where the soil is more fertile and drier and there is less danger of frost at crucial periods of the agricultural season. Rural settlement is scattered, rarely in village units, but the houses may be aligned along a road or a navigable waterway. The pattern of settlement in Finland has been seriously disturbed by the movement of evacuees from the ceded territories, although this has accelerated the development of the southern provinces. With a reduction of 11·9 per cent of her pre-war area, 11 per cent of the population was displaced, and the resettlement had to be undertaken in a land suffering from war damage and the burden of reparations. Some endeavour was made to settle a proportion towards the north. The standard of living has, of necessity, been reduced by placing these people on land of lower productivity. In Iceland, with the lowest

density of population of any European country, the figure of effective density is raised to 15·6 persons per sq. mile (6 per sq. km.) if the occupied area be taken and not the total area. Even this low figure represents overpopulation in relation to the rural resources and if it were not for the fishing the standard of living would be low. Settlement in the rural districts is dispersed in order to tap the pastoral areas.

The drift to the towns is an alarming feature of Scandinavian life and the towns generally are growing at a faster rate than the population as a whole, so that what is regarded as an unsatisfactory situation is developing, particularly with regard to some of the capital cities.

Population of capital cities

Year	*Population of*	*As a percentage of the country*
1959	Reykjavik	42·0
1960	Tórshavn	17·7
1959	Oslo	13·4
1959	København	22·0
1961	Stockholm	9·3
1959	Helsinki	10·3

Various incentives have been given to encourage people to remain in the rural districts—in Iceland, for example, payment of agricultural subsidies to offset high wages offered in the towns. Despite these efforts urbanisation is increasing with its concomitant of rural depopulation and difficulty of maintaining agriculture and forestry. Improved communications have accelerated the drift to the towns, and the market towns with rail and road facilities have grown while other ancient nucleations have remained static. In Norway, the Færoes, Iceland and Greenland the growth of the fishing towns has been a feature of coastal settlement since the introduction of power-driven craft, which allowed a well-favoured port to tap extensive fishing grounds.

EMIGRATION

Emigration has long been a feature of Scandinavian economy. Swedes emigrated to the Delaware lands in 1630—but it only reached massive proportions after 1850. Poor harvests coincided with the discovery of goldfields in California, Alaska and Australia and men were enticed by newspaper accounts of riches to be obtained and free

land grants. A common route was from Göteborg to Hull, across England to Liverpool, and then by an emigrant ship to North America: the total fare from Sweden to New York was then only about £5. From Norway 870,000 persons left between 1835 and 1935, a loss proportionally greater than that from any other European country except Ireland. In the years 1851–1923 over one and a third million persons left Sweden, of whom about one million went to North America and most of the others to Australia and the Cape Town and Johannesburg regions of South Africa. Statistics of

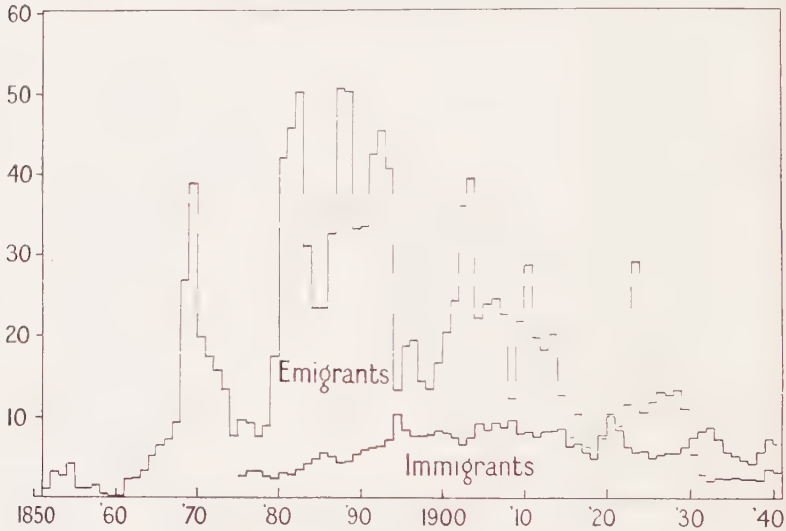


FIG. 189.—POPULATION MIGRATION IN AND OUT OF SWEDEN, 1850–1940.
Based on G. Sundbärg, *op. cit.*, Table 72 and *Årsbok*, 1940, Table 34.

emigration from Iceland show that the peak was in 1887 when some 2,000 persons left and while the absolute figure may not be great it amounted to about 3 per cent of the total population. The area with the greatest number of Icelanders abroad is the prairie region of Manitoba and Saskatchewan. From Finland the flow of emigrants started later and continued longer; between 1901–10 about 160,000 persons migrated, mainly to America, and from 1921–30 nearly 60,000, but this time to Europe and to South America.

The stream from the home countries of Norway, Sweden and Denmark had largely ceased to flow before 1914, with increasing prosperity in the homeland. Under the U.S. Immigration Law of 1924 the Scandinavian people were regarded as desirable immigrants

but the quota allowed was not always taken up. From all the Scandinavian countries emigration virtually ceased with the onset of the economic depression. Some of the emigrants, who as a group acquired a reputation for being industrious and honest, prospered and found fortune as engineers, scientists and artists. Most of the Scandinavians in North America went first to the forest and prairie lands from Minnesota westward to the Dakotas and northwards into Canada and there the colonies of Scandinavian-born are still

FIG. 190.—SCANDINAVIAN SETTLEMENT CENTRES IN NORTH AMERICA.

The main areas are stippled and the dots have no quantitative significance. The isotherms are of temperatures reduced to sea-level.

Based on Census Reports of Canada and U.S.A., *Atlas of Canada*, 1915, and *Atlas of the Historical Geography of the U.S.A.*, 1932.

considerable although numbers have moved westwards into the state of Washington and into British Columbia. In British Columbia Norwegians play a bigger part in the fisheries than do the Swedes but the latter account for one in twelve of the lumbermen. Not many of these forest workers are married and so there is not the same development of towns with Swedish character as occurs in the Prairie Provinces of Canada. As Helge Nelson has shown, most of the Swedish people in North America are found in the areas which have a July temperature of under 77 F. (25 C.): the only important exception to this generalisation is the Swedish colony in California.

CHAPTER 23

COMMERCE AND TRADE

HISTORICAL INTRODUCTION

Mention is made of some of the early trading activities of the Scandinavians in the regional chapters, but a review of the commerce and trade may well commence with the days of the Hanseatic League. During the centuries of power of the League trading centres were established at Viipuri (Viborg), Åbo, Stockholm, Visby, Bornholm, Malmö and Bergen in order to tap the vast wealth of the seas: of these towns Visby and Bergen were for a period very important but later their trade declined even before the Hanseatic League itself collapsed. From Sweden the merchants, especially those of Lübeck, carried copper, gold and silver; from Bornholm and Gotland they obtained building stones; from Visby and Bornholm herring, and from Bergen cod, which had been obtained in the north. In return, grain was carried northwards, as well as salt for curing. These trade channels concentrated at Visby which provided a focus for the river routeways of eastern Europe. The Sea Laws drawn up by the merchants of Visby were founded on older laws: this set of rules was translated by Thomas Petyte and published in *Rutter of the Sea*, 1536. Our word *shilling* is said to be a corruption of the Visby *skilling* (O.E. *scilling*) and *sterling* is said, although this is now considered unlikely, to be a corruption of *Österling*; thus the imprint of Gotland trade is still found in modern commerce, although Sweden was freed from Hanseatic domination four hundred years ago and the power in Bergen had waned before the end of the sixteenth century.

Following the golden age of Sweden and Denmark, the eighteenth century was one of peace, and Denmark, with its control of the Sound, became one of the chief trading nations of the world; but this prosperity was abruptly terminated by the capture by the British of her merchant fleet during the Napoleonic Wars. Trade stagnated for the following half century and other ports of northern Europe, such as Hamburg, replaced Kobenhavn in the control of Baltic trade. Not until the industrial countries of Britain and Germany demanded ever increasing quantities of food and timber did the Scandinavian countries play again a considerable part in world trade, a part which, from 1875, was enhanced by the rise of specialist industries within the home countries to the east of the North Sea.

After the Napoleonic Wars the next major regression came with the First World War; this materially damaged the trade and activity of Denmark but turned Sweden from a debtor to a creditor nation and, by increased industrialisation and the provision of electricity, resulted in great enhancement of her trading capacity. Efforts to offset the economic depression of the early '30s were hardly successful before the onset of the Second World War profoundly affected trade. Finland, Denmark, Norway, the Færoes, Iceland and Greenland were either occupied or actively fought over and rehabilitation during the inflationary post-war period has strained their resources considerably. Sweden alone, naturally the wealthiest, was little

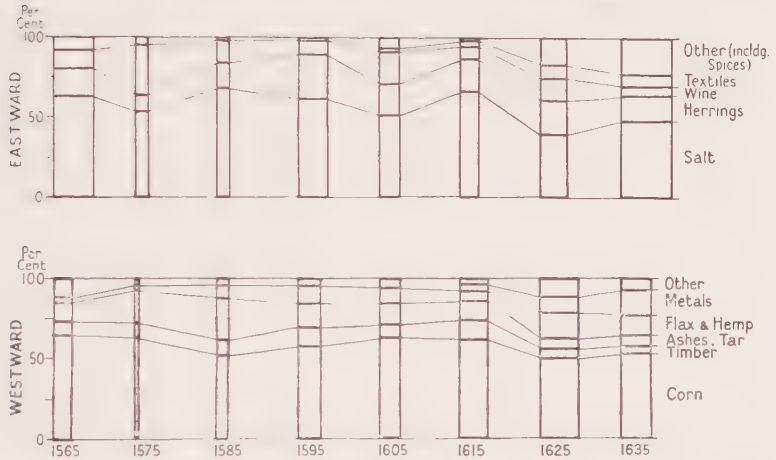


FIG. 191.—BALTIC TRADE IN DUTCH SHIPS THROUGH THE SOUND, 1565–1635.

Trade fluctuated with war and with harvests but the items remained staples except for the rapid increase, in the seventeenth century, of Swedish iron and copper. The width of the columns is proportional to the trade in the year.

Based on data in A. E. Christensen, *Dutch trade to the Baltic about 1600*, Copenhagen, 1941, pp. 465–6.

affected by direct war action but, isolated between belligerents, her trade was greatly reduced.

Until the restrictions were eased in 1856 Denmark controlled the trade of the Færoes and wool was the staple, but since then the export list has been completely dominated by the products of the fisheries. The Danish control of the Greenland trade has lasted since 1774 but the conditions of trade have been modified since the last war with the relaxation of certain controls.

Trade with Iceland became a Danish monopoly after 1602 and was not freed until 1854. The island's limited resources make trade essential to provide amenities and it was for this reason that the

decline in the salt-fish trade between the two world wars was felt so acutely. In order to conserve currency there were strict controls: for example, in order to obtain fresh fruit, such as oranges, it was necessary to have a medical certificate—a situation which seemed severe to British people in 1938 but to which they themselves became accustomed not so many months later.

Finnish trade in the nineteenth century was greatly affected by the political connection with Russia; after the First World War there had to be a fresh development of new markets at a period when the country was struggling to re-equip her industries. Before the Second World War Finland had succeeded in creating a favourable trade balance but this was abruptly reversed in 1940 by the onset of war, and since then trading conditions have been made very difficult by reparation demands, which have been the over-riding factor controlling the commercial pattern.

RECENT COMMERCIAL POLICIES

Norway, Denmark and Sweden could afford to pursue liberal policies in trade because of their large foreign export trades, and, in the case of Norway, the exceptionally large merchant and whaling fleets. Norway for long was exceptionally liberal and not until 1933 was there a bargaining agreement with the U.K. The war and its aftermath resulted in the adoption by Norway of a strict licence system in an attempt to balance trade, to develop home industries and to prevent inflation. Part of the trade policy, as in Iceland, has been to prevent foreign control of home industries. Since the war Norway has made quota agreements with most European countries in an effort to restrict excessive imports: the need for these may be realised from the fact that the import trade of 1947 amounted to one-third of the total national productivity as against one-quarter in 1938.

Denmark is one of the countries which has for long believed in Free Trade and kept the rate of duties low, while to facilitate the transit trade bonded warehouses were provided at the ports and a Free Port at Kobenhavn. Under the stress of the early 1930s, when Denmark was unable to sell her produce abroad, there had to be restriction on imports so in 1932 an import licence system was introduced which was later extended to the export trade. During the period of the economic depression and after the Second World War several agreements were made in order to stimulate trade. Denmark, with her dependence upon imported fertilisers and feeding stuffs and on agricultural exports, was particularly vulnerable. An Anglo-Danish commercial treaty was negotiated in 1933, but British

concessions were limited because of the Empire preference scheme agreed at Ottawa the previous year. From 1932 Denmark also had a commercial treaty with Germany while in the same year a strong control was imposed on imports to avoid an unfavourable balance of trade. After the war new agreements were reached with Britain by which butter and bacon would be sent to the United Kingdom in exchange for coal and steel. Bilateral agreements were also made with Norway, Sweden, the U.S.S.R. and some other European countries. When Denmark joined the organisation for European Economic Co-operation many of the licence controls were relaxed in order to increase foreign trading.

Dependent upon trade for all but the bare necessities of life, Iceland was hard hit by the restrictions on the salt-fish trade imposed in the 1930s. Although Iceland did not purchase much from the Catholic Mediterranean area it did through sales there obtain the currency for purchases of foodstuffs, building materials, fuel and machinery from Denmark and Britain, and when trading contracted a system of strict import controls had to be introduced and attempts were made to manufacture goods within Iceland. During and immediately following the Second World War Iceland was prosperous and extensive additions to her capital equipment were made under the artificial conditions which prevailed. Fish commanded high prices in Britain and the intake of currency was great. Icelandic currency is now closely linked with sterling.

Because of forced export for reparations, and lack of financial reserves, the Finnish government concluded a number of bi-lateral trading agreements and since reparations payments ceased in 1952 the balance of trade should be satisfactory although adjustments will be required, such as the import of fuel to replace the wasteful burning of timber for urban central heating.

IMPORTS

Minerals

Highest in the list of mineral imports are coal and oil although the alternative home sources of peat, wood and hydro-electricity can be used to provide much of the energy required under modern economy. The coal resources of the Scandinavian World, excluding Svalbard, are of slight importance and of poor quality.

Food

Imports have to be made of some food items although the incidence of these is less in the main Scandinavian countries than it is in such a heavily industrialised country as the United Kingdom.

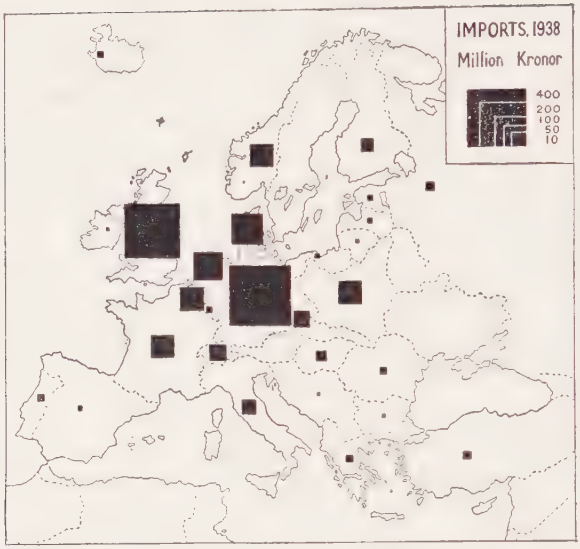


FIG. 192.—SWEDISH IMPORTS FROM EUROPE, 1938.

Note the dominance of western European trade and the little traffic with eastern Europe.

Based on *Stats. Årsbok*, 1941, pp. 164–5.

FIG. 193.—SWEDISH IMPORTS FROM BEYOND EUROPE, 1938.

In 1938 trade from the Americas was, in value, more important than that from the other continents combined.

Based on same source as Fig. 192.

Gross Food Supplies, (a) 1934–8 and (b) 1959–60

(Domestic production as percentage of requirements: over 100 represents a surplus available for export)

	Denmark		Finland		Norway		Sweden		U.K.	
	(a)	(b)	(a)	(b)*	(a)	(b)	(a)	(b)	(a)	(b)
Wheat and rye	60	78	78	5	16	6	103	90	24	36
Other cereals (excluding rice)	91	87	92	96	67	70	94	90	41	57
Potatoes, etc.	102	111	100	99	100	100	100	93	97	93
Refined sugar	101	125	10	20	—	—	98	83	21	26
Pulses	82	92	100	26	25	7	100	64	15	32
Meat	192	281	103	101	99	100	104	106	48	59

* 1951–3.

(Based on *U.N. Statistical Yearbook, 1958*, Table 124, and *ibid, 1961*, Table 125)

These food imports help to maintain an average daily calorie supply of about the same amount, 3,000 to 3,200, in each of the countries. This intake is greater than in eastern and southern Europe partly because of the higher intake of milk and potatoes.

Miscellaneous

In addition to colonial and other foodstuffs which cannot be produced in the various countries, certain of them, particularly Finland, need to import machinery to allow an increasing industrial development. But with greater industrialisation there will come the problem of finding markets in the face of competition from established producers.

EXPORTS

Minerals

Minerals dominate the exports of Sweden (iron ore) and of Greenland (cryolite). When there is a reduced demand for cryolite, as there is periodically, a heavy financial burden falls on Denmark for maintaining the social services in Greenland. Fortunately for Sweden the iron-ore, which was largely responsible for turning her economy from that of a debtor nation to a creditor, has not suffered any serious depression except in wartime.

Forest wealth

Finland's foreign commerce is dominated by forestry: four-fifths of the export trade comprises forest products, and not until the 1870s

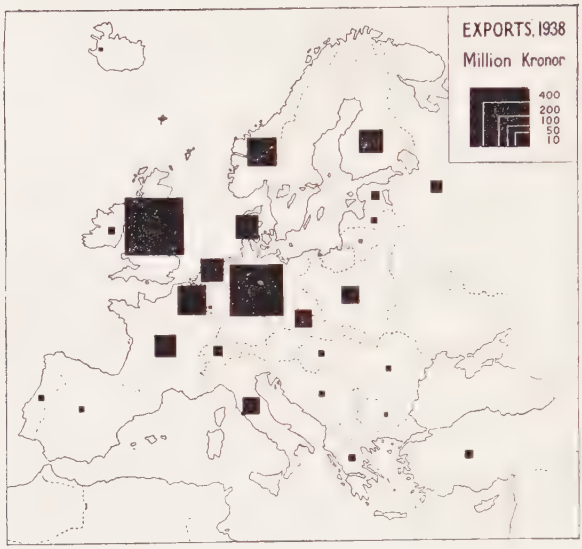


FIG. 194.—SWEDISH EXPORTS TO EUROPE, 1938.

By comparing with Fig. 192 it is seen that with countries such as Norway, Finland and Great Britain, Sweden sold more than she purchased from them.

Based on same source as Fig. 192.

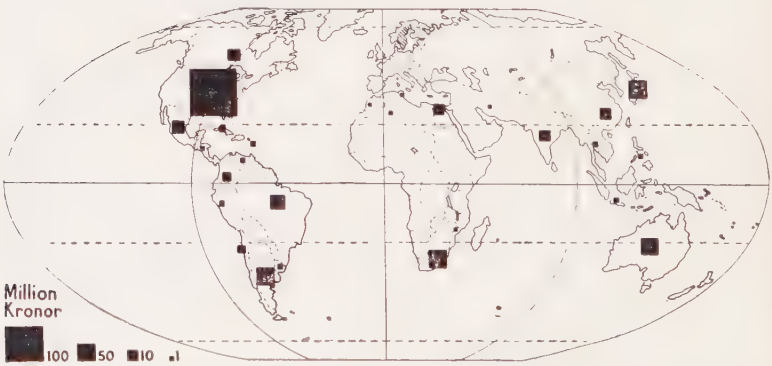


FIG. 195.—SWEDISH EXPORTS TO BEYOND EUROPE, 1938.

The Americans did not purchase so much as they sold to Sweden but the discrepancy was partly balanced by the greater sales in Africa, Asia and Australia.

Based on same source as Fig. 192.

when the timber trade became active did the foreign trade of Finland rise appreciably. For long Britain has been the leading importer from Finland, but Germany runs second and since the war other Scandinavian countries have become important, although Norway and Sweden are themselves rival producers of timber. Just over one-fifth of Norwegian exports consist of timber and its products.

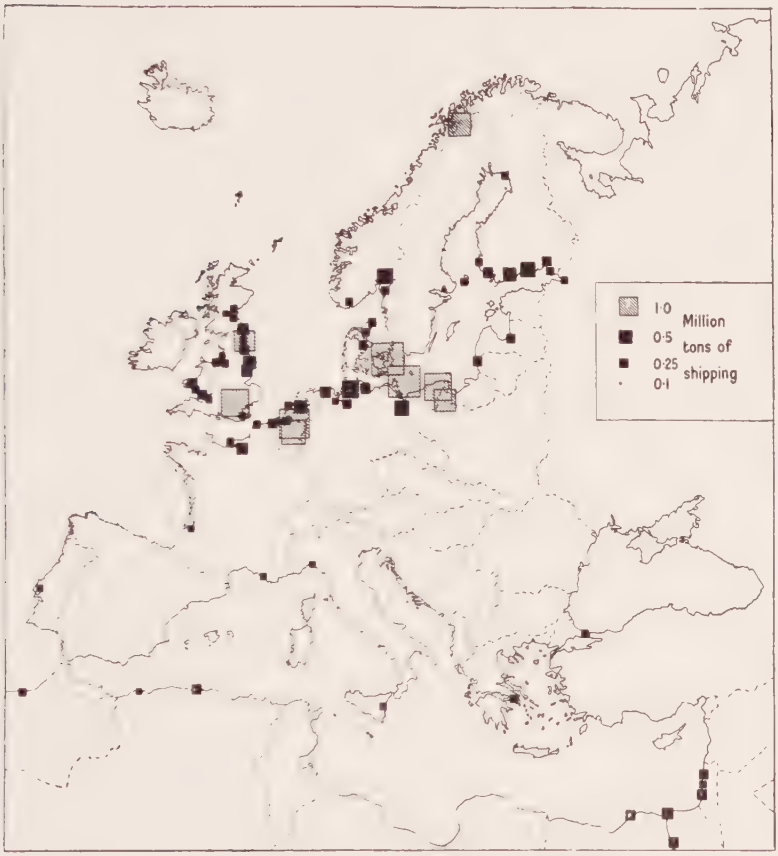


FIG. 196.—EUROPEAN AND MEDITERRANEAN PORTS AND SWEDISH SHIPPING, 1938.

Foreign ports which entered or cleared 100,000 tons or more of Swedish shipping in 1938 are shown. Those which had a million tons or over are shown by the open square ruled.

Based on *Sjöfart*, 1938.

Agricultural Products

In Denmark, the country which has most "industrialised" its agriculture, the output of farm produce had reached astronomical proportions by 1938, when 1,716 million eggs were exported. Such totals convey little and the significance is better appreciated from the fact that before the depression of the 1930s one-quarter of the national income came from agriculture, a proportion only attained through the medium of imported fertilisers and feeding-stuffs. Before the Second World War Denmark was the world's largest exporter of bacon and eggs, most of which went to Britain as did much of the considerable butter export. The importance of the co-operative schemes in the export of the agricultural produce of Denmark can be scarcely overemphasised: the slaughter of 85 per cent of the pigs converted for bacon and practically all the marketing is done by the co-operative bacon factories while the export of eggs has been built up by a co-operative egg-export association. The economy was greatly disrupted by the war, with military occupation and the virtual cessation of overseas trade, and was also affected by the post-war scarcity of feeding materials which, by reducing the milk yield, reduced the butter and cheese available for export. Prior to the war Finland was able to export pork but the decrease in the pig numbers and the pressure on resources with the displaced population have greatly reduced this trade. Agricultural produce is not of significance in the Swedish export list.

Fisheries

Iceland and the Færoes are both dependent upon the income derived from fish exported and catches landed abroad while Norwegian trade is also largely influenced by her fisheries, which provide over one-seventh of the value of the exports.

Tourism

The tourist traffic, which includes in all statistics all non-immigrant travellers, is an important feature of the modern world and the physical and cultural attractions of the Scandinavian countries invite considerable numbers of visitors.

Norway undoubtedly has a favourable balance from this traffic but in the case of Sweden, although there is apparently a slightly favourable balance, it is probable that there is in fact a slight deficit for the Swedes travel widely. The Icelandic government has a State Tourist Bureau to encourage tourism, and it has been found necessary to supplement the passenger shipping services during the tourist season. The small unit of the Færoes also maintains an official Tourist Bureau.

International Tourist Travel, 1956

(*'000 persons*)

From \ To	Denmark	Finland	Iceland	Norway	Sweden
Belgium . .	4·0	0·9	0·02	2·9	6·1
Denmark . .	—	6·9	3·0	88	966 [1951]
Finland . .	15	—	0·07	37	187 [1952]
France . . .	15	4·1	0·1	13	27
Germany, Western	55	15	0·8	30	162
Iceland . .	3·8	0·2	—	0	2·5 [1952]
Norway . .	47	16	0·4	—	856 [1951]
Sweden . .	115	158	0·6	700	—
U.K. . . .	30	6·4	0·7	59	59
U.S.A.. . .	85	9·4	2·8	46	85
Total tourists .	433	240	9·5	1,019	470

Many of the "tourists" into Sweden from Norway, Denmark and Finland were daily visitors and, with relaxation of controls over such movement, the statistics are no longer published.

(Based on *U.N. Statistical Yearbook, 1958*, Table 143)

BALANCE OF TRADE

From data collected by the International Monetary Fund organisation with reference to balance of payments in international trade it is seen that in 1938 Iceland, with a slight deficit, was the only Scandinavian country which did not have a credit balance at the end of the year; but in the post-war period 1946–50 Norway had an appreciable credit, Iceland and Sweden slight credit, Denmark a slight deficit and Finland a heavy deficit. The war disturbed the flow of international trade and Iceland and Finland, which had a favourable balance in most pre-war years, joined the other Scandinavian countries in having a considerable excess of imports

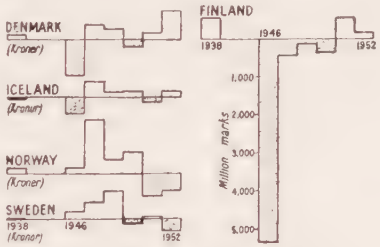


FIG. 197.—CREDIT AND DEBIT BALANCES.

1938 is given as a pre-war example and the post-war situated from 1946–51 is shown by the same scale. Debits in the trading position are emphasised by a light stipple in the column below the baseline. The post-war financial position of Finland was the worst but all these countries have had years of difficulty. For 1952 read 1951.

Based on data in U.N. Statistical Yearbooks.

over exports even with rigid controls over imports. Coal and machinery, vital items, had risen in price more than the exportable commodities.

The Scandinavian countries of Denmark and Sweden have a high standard of living and, since these countries cannot be self-supporting, this can only be maintained by being able to export sufficient goods. Before 1939 most of Danish purchases abroad were met by sales with only a narrow margin to be covered by payments received from shipping services; but after the war there was a deficit, and to

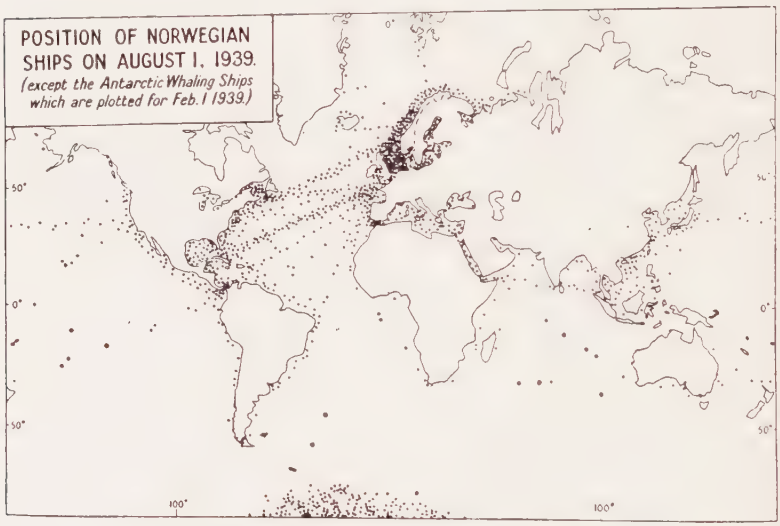


FIG. 198.—NORWEGIAN SHIPPING, 1939.

This map is based on a survey of the location of all Norwegian ships. The distribution reflects the importance of the Norwegian fleet in world trade routes and also in the whaling activities of the Antarctic.

Based on *Norges handelsflåtes fordeling på verdenshavene*, 1939.

meet this Marshall aid was accepted for the construction of new industrial plant. In the post-war years the *per capita* burden of reparations on the Finnish people approximated to the amount of American aid received by the other countries of northern Europe. During this century Sweden has turned from being only a producer of raw materials, such as timber and iron-ore, to a supplier of manufactured goods, and because of this the value of her exports was great. In recent years, however, to maintain the standard of living, imports have exceeded the value of the exports. Part of the apparent deficit is offset by tourism and by the earnings of Swedish shipping.

Norway has had for long an adverse balance of direct trade which has been met by returns from her shipping interests. With the need to replace lost shipping and to reconstruct the pattern of life in the north her economy was considerably disturbed by excessive capital expenditure. Prior to the war Germany was the principal supplier of imports but the United Kingdom is now the leading trader with Norway.

Iceland has a lower standard of living and so long as the fishery products can be sold the economy is satisfactory but since the war,

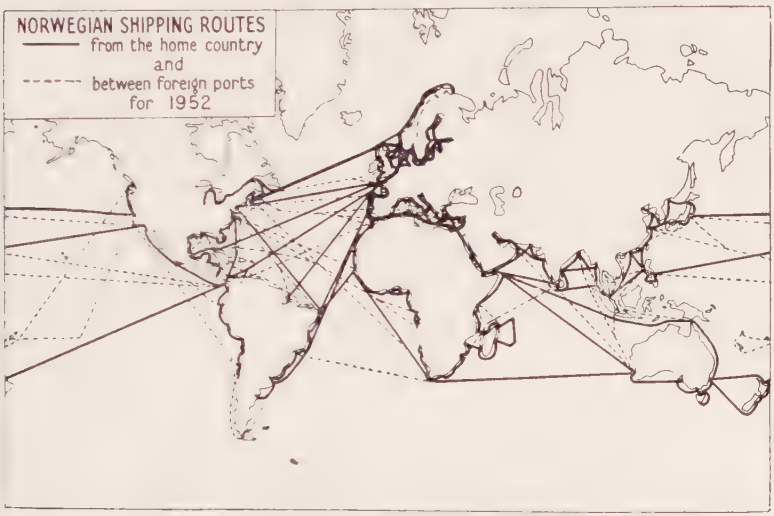


FIG. 199.—NORWEGIAN SHIPPING ROUTES, 1952.

Few, if any, trade routes are not served by Norwegian ships and the income is of importance in maintaining the balance of payments. Some Norwegian ships never call at Norwegian ports during their commercial life.

Based on map supplied by Norwegian Embassy.

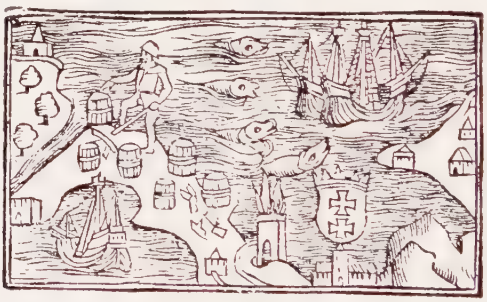
with increased costs and difficulty in selling fish, it has been difficult to make ends meet.

The true balance of trade in Finland since the war is almost impossible to assess owing to the reparations which have had to be made, but despite being a country poor in natural resources, other than forests, Finland has succeeded in overcoming the burdens both of the economic depression of the '30s and of reparations since 1944. The disturbance to the economy, by building plant to supply reparations, has been so great that not until some time has passed will it be possible to see if the provision of this greatly enlarged industrial capacity has gone beyond her true resources.

POSTSCRIPT

In this volume an attempt has been made to introduce the reader to some of the facets of the geography of the Scandinavian World. The distinctive character of this area has coloured the story of empires and democracies. Bacon might write "The mould of a man's fortune is in his own hands" but, without stressing causal geography, it is clear that here, as elsewhere, the greater pattern of opportunity is controlled by the environment.

In reading the proofs I have been constantly reminded of the personal contacts during a quarter of a century. It was not only scholars and officials but also the people met in farms and villages, on trains and ships or in the streets who gave the friendly co-operation which was a constant source of delight. I can only exhort my readers, wishing to fill the numerous gaps in a single volume on such a wide sector of the globe, to visit the countries and to experience the fascination of the north.



APPENDIX A

CONVERSION TABLES

Metric to British Units

LENGTH

			Approximate British Equiv.
Mile (metric)	= 10,000 metres	=	6·214 miles
Kilometre	= 1,000 metres	=	0·6214 mile
Metre	= 1 metre	=	39·37 inches
Centimetre	= 0·01 metre	=	0·3937 inch
Millimetre	= 0·001 metre	=	0·03937 inch

In Great Britain the value of a metre is 39·37079 inches, whereas in the U.S.A. it is legalised at 39·37 inches.

1 statute mile (5,280 ft.)	= 1·609 km.
1 yard	= 0·914 m.
1 inch	= 2·54 cm.
1 nautical mile (British) (6,080 ft.)	= 1,853 m.
1 nautical mile (International) (6,076 ft.)	= 1,852 m.

AREA

			Approximate British Equiv.
Square kilometre	= 1,000,000 sq. m.	=	247·1 acres
Hectare	= 10,000 sq. m.	=	2·471 acres
Are	= 100 sq. m.	=	119·6 sq. yds.
1 square yard	= 0·836 sq. m.		
1 acre	= 4,047 sq. m.		
1 square mile	= 2·59 sq. km.		

CAPACITY

Hectolitre { = 100 litres { = 2 bushels 3·35 pecks dry measure
= 0·1 cu. m. } *or* 26·42 gal. liquid measure.

Litre = 0·908 qt. dry measure *or* 1·0567 qts. liquid measure.

1 standard gal. (231 cu. in.) = 3·785 litres

1 imperial gal. (277 cu. in.) = 4·543 litres

Note; 1 bushel (U.S.) = 35·24 litres
1 bushel (British) = 36·35 litres

WEIGHTS

		Grammes		*Avoirdupois*
1 metric ton (millier)	=	1,000,000	=	2,204·6 lb.
1 quintal	=	100,000	=	220·46 lb.
1 kilogramme	=	1,000	=	2·204 lb.
1 avoirdupois ounce	=	28·3495	grammes	
1 troy ounce	=	31·103	grammes	
1 pound	=	453·59	grammes	
1 ton (2,240 lb.)	=	1,016·05	kilogrammes	

YIELD PER UNIT AREA

Tons per acre	*Metric tons per hectare*	*Quintals per hectare*
1	2·5107	25·1071
0·3983	1	10
0·0398	0·1	1

TEMPERATURE

To convert Fahrenheit degrees to Centigrade subtract 32° and multiply the remainder by 5/9.

To convert Centigrade degrees to Fahrenheit multiply by 9/5 and add 32°.

PRESSURE (converted at 32°F. (0°C.) in Latitude 45°)

1,000 millibars = 750·1 mm. (29·53 inches) mercury
30·00 inches (762·1 mm.) mercury = 1,016 millibars
29·00 inches (736·6 mm.) mercury = 982 millibars

APPENDIX B

SELECTED BIBLIOGRAPHY

For some parts of the world there is a paucity of geographical literature but this is not so with Scandinavia. For many years there has been a considerable volume of material published and the following bibliography draws attention to some of the more important works and periodicals. Many Scandinavian periodicals have summaries in a major west European language if the article itself is in the language of the country. The list of periodical accessions, "New geographical literature and maps", published by the Royal Geographical Society, and the equivalent published by the American Geographical Society are invaluable guides to material published in geographical and kindred journals and should be used to supplement the following list of books.

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